United in heart, divided in wallet

Tests of alternative models of family behaviour

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United in heart, divided in wallet

Tests of alternative models of family behaviour using data from the US Consumer Expenditure Survey 2010

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Summary

Over the last decades, a substantial amount of empirical evidence has deemed the unitary model of family behaviour inadequate. A range of alternative models have been developed, but there is no general agreement as to which one is the most suitable. Empirical evidence may even suggest that the appropriate model differs between different parts of the world.

A key feature of non-unitary models is that they are open to the possibility that intra-household income distribution may affect household demand if the husband and the wife have different preferences. In my thesis, I present alternatives from three broad classes of models, all of which have in common that both individual preferences and the decision process matter. One alternative is the non-cooperative model (Ermisch 2003; Ulph 2006) in which it is assumed that family members are economically detached from one another and behave strategically according to their own private agendas. Another alternative is the collective model (Chiappori 1988) which postulates that family members will cooperate, but that the gains from cooperation might be unevenly distributed depending on each family member's personal bargaining power. Bargaining models (Manser and Brown 1980; McElroy and Horney 1981; Browning and Lechene 2001) take it one step further by specifying a bargaining process directly, usually assuming Nash-bargaining. The unitary model, the non-cooperative model, the collective model and the bargaining model are fundamentally different and in many aspects mutually exclusive.

Using data from the US Consumer Expenditure Survey 2010, I select a sample of 812 quarterly observations of couples with children where both spouses are in full time employment. Based on the individual income records provided in the survey, I estimate how much of family income is formally controlled by the wife. I then use the expenditure data to examine whether the wife's share of household income has a systematic impact on household spending on several categories of goods. The categories are children's clothing, household operations, household equipment and health insurance – goods that can reasonably be classified as public to the spouses. I then estimate the impact of the wife's share of household income on household spending within the context of a variety of model variants that impose different restrictions on the response patterns. Finally, I conduct a series of statistical tests to see if one type of model fits the data better than other models do. My findings indicate that

the traditional unitary model of family behaviour has poor explanatory power, and that the collective model (Chiappori 1988) is a suitable candidate for its replacement. In this context, that means that the distribution of income between the spouses has a significant impact on how the household spends its resources.

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Any errors or inaccuracies in this thesis are, of course, my own.

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1 Introduction

> *Seeing then that the state is made up of households, before speaking of the state we must speak of the management of the household.*
>
> Aristotle in *Politics* Book I Part III

The role of the family has changed substantially through the centuries. In ancient times, finding a partner and raising children could be a question of survival. Today, it is usually a matter of personal preference – at least in modern Western cultures. But although the traditional nuclear family may now be just one of several options an individual can choose, for many it is still the principal institution for affinity between partners, co-residence, child-rearing and organizing everyday life. Therefore, the family also plays a central role in public debate. You would be hard pressed to find a Western politician who does not claim to promote the best policies towards families and children. As in many running debates, there is a battle between ideologies, beliefs and claims to the truth – which often turns out to be quite elusive.

Economic concepts such as scarcity, trade-offs and conflicting interests are essential ingredients in family interactions. Thus, economists may provide valuable knowledge for decision makers about important aspects of family life. Indeed, many government policies aimed at families are *economic* policies that alter the choices and incentives family members face. Without understanding how families react to changes in the economic environment, these policies become random experiments that may or may not work as intended. Economists might not have all the answers as to what are the *best* family policies, but there are strong reasons to believe that decisions based on empirical observations are preferable to those based on hopeful guesswork.

A central topic in the current academic debate among family economists is how to accurately model family behaviour. There exists a variety of models that are fundamentally different, both in assumptions and predictions. There is, however, no general agreement regarding which type of model is the most appropriate given the context. This presents a serious challenge to family economists, because when plausible assumptions and conclusions collide,

answering key questions can become difficult. A possible path to resolving some of the dispute is to conduct empirical tests where alternative models of family behaviour are pitted against each other. This is what this thesis is about.

A focal point for the empirical analysis in this thesis is household demand for intra-household public goods, and how this is affected by intra-household income distribution. This is one of the areas in which different models predict radically different outcomes. It is also an area suitable for empirical testing, because it requires data that to a certain extent is readily available, namely income data and expenditure data. As in many fields of research, the data is never as complete and as accurate as researchers would like, but it is nevertheless of such quality that empirical analysis seems possible and fruitful.

Investigating which models of family behaviour are plausible, and which that are not, is important for several reasons. First, finding the appropriate model is interesting by its own right in the sense that it satisfies an intellectual curiosity. Second, finding the appropriate model can help us provide better answers about the family and their responses to policies and changing times. Most importantly, perhaps, how household demand responds to changes in intra-household income distribution is of interest to anyone concerned with distributive justice. If economic factors affect bargaining power within marriage, then skewed opportunities in the labour market may be amplified in the family. This is highly relevant in regards to fairness and gender equality. Also, if intra-household allocation of goods is sensitive to outside influences such as divorce laws or women's wages, so is quite possibly the welfare of children. But if some outcomes are deemed unsatisfactory, what can policy makers do about it? That question would be hard to answer without understanding the family decision process.

There is considerable agreement among economists that the traditional unitary model of family behaviour, a model that doesn't specify a decision process at all, is inadequate and in need of replacement. In this thesis, I present alternatives from three broad classes of models, all of which have in common that both individual preferences and the decision process matter. One alternative (section 3.3.2) is the non-cooperative model (Ermisch 2003; Ulph 2006) in which it is assumed that family members are economically detached from one another and behave strategically according to their own private agendas. Another alternative (section 3.3.4) is the collective model (Chiappori 1988) which postulates that family members will

cooperate, but that the gains from cooperation might be unevenly distributed depending on each family member's personal bargaining power. Bargaining models (Manser and Brown 1980; McElroy and Horney 1981; Browning and Lechene 2001) (section 3.3.5) take it one step further by specifying a bargaining process directly, usually assuming Nash-bargaining. The unitary model, the non-cooperative model, the collective model and the bargaining model are fundamentally different and in many aspects mutually exclusive.

The search for the appropriate economic model of family decision making may yield different answers across cultures and contexts. It is a task that will most likely go on for many years to come, and I do not seek to provide any final answers. The goal of this thesis is merely to provide a relevant piece for a rather large puzzle.

Using data from the US Consumer Expenditure Survey 2010, I select a sample of 812 quarterly observations of couples with children where both spouses are in full time employment. Based on the individual income records provided in the survey, I estimate how much of family income is formally controlled by the wife. I then use the expenditure data to examine whether the wife's share of household income has a systematic impact on household spending on several categories of goods. The categories are children's clothing, household operations, household equipment and health insurance – goods that can reasonably be classified as public to the spouses. I then estimate the impact of the wife's share of household income on household spending within the context of a variety of model variants that impose different restrictions on the response patterns. Finally, I conduct a series of statistical tests to see if one type of model fits the data better than other models do. My findings indicate that the traditional unitary model of family behaviour has poor explanatory power, and that the collective model (Chiappori 1988) is a suitable candidate for its replacement. In this context, that means that the distribution of income between the spouses has a significant impact on how the household spends its resources.

The rest of this thesis is structured as follows: Chapter 2 provides a historical account of some of the ideas that have shaped the field of family economics. Chapter 3 contains the theoretical backdrop, in particular a presentation of three classes of models that serve as viable alternatives to the standard unitary model. These alternative models form the basis for the empirical tests. Chapter 4 describes the data used for these tests, and also some of the challenges facing empirical research of this kind. Chapter 5 presents the main findings and some possible interpretations of the results, before chapter 6 concludes. Detailed regression

results and the composition of the public goods chosen as dependent variables can be found in the appendix.

2 Background

2.1 Before the 20th century

The branch of the social sciences that we today know as *economics* has always recognized "the family" or "the household" as an important economic institution. After all, the origin of the word "economics" is "oikonomikos" – the title of the Greek historian and philosopher Xenophon's treatise on managing an agricultural estate (Backhouse 2002 p. 14).[1] In the 18th century, economists such as Richard Cantillon, Adam Smith and Robert Malthus investigated the link between economic circumstances and human reproductive activities, and how this affected population size (Browning et al 2011 p. 4; Sandmo 2011 p. 64). During the methodological debate following the development of theoretical economics and the principle of self-interest in the 19th century, economists on both sides used family behaviour to support their own views. John Stuart Mill, widely credited as the father of the utility maximizing *homo economicus,* used as an example how Swiss families shifted resources between home manufacturing and agriculture depending on the season and the weather conditions (Mill 1909 Bk. III Ch. XXV).[2] The Irish economist Tomas E. C. Leslie, on the other hand, dismissed the emphasis on rational self-interest in economics when he wrote that "among the chief motives to production, the most powerful of all to accumulation, and deeply affecting consumption and distribution, are conjugal and parental affection" (Leslie 1884 p. 196).[3] But although many economists before the second half of the 20th century stressed the importance of the family as an economic institution, few attempts were made at actually modelling family behaviour. The family remained a "black box" until the 20th century.

2.2 The impact of Gary Becker

What really stands out as seminal contributions to the field of family economics are the works of Gary Becker (1930-). Using the tools of neoclassical microeconomics, he moved into fields not commonly associated with economics such as discrimination, crime, drug addiction and family behaviour. This way of expanding the scope of economics into areas usually

[1] The Greek word «oikos» literally means «household» (see Merriam-Webster's online dictionary).
[2] The first version of this book was published in 1848.
[3] The original essay titled "Political Economy and Sociology" was first published in *Fortnightly Review* January 1st 1879

occupied by other social sciences, sometimes referred to as "economic imperialism", has at times been subject to extensive ridicule (Sandmo 2011 p. 445; Backhouse 2002 p. 311).[4] Indeed, Becker himself did not escape mockery, but that does not seem to have limited his efforts.[5] Becker's *Treatise on the Family*, first published in 1981, is one of the most important works in modern family economics (Ermisch 2008). Topics include "marriage markets", intra-household resource allocation and welfare, investment in children and inter-generational transfers. Becker's importance lies not necessarily in how many people *agree* with his ideas, but in how many of his successors that define their position *relative to him.* Or as Robert Pollak, a long standing critic of Becker puts it: "His ideas have dominated research in the economics of the family, shaping the tools we use, the questions we ask, and the answers we give" (Pollak 2003 p. 40). Pollak elaborates on this by conceding that even though his own work could be seen as criticizing Becker, it could also be seen as reshaping Becker's tools (ibid) – which in a sense is *following* Becker. As a further testament to Becker's importance, he was awarded The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel in 1992.

To family economics, Becker introduced familiar economic concepts such as exogenous preferences, rational behaviour and utility maximization. One of his best known propositions is the "Rotten Kid Theorem" which says that a selfish child will behave selflessly towards the family (i.e. maximize family income) if the family is headed by an altruistic parent who is making transfers to the other family members (Becker 1999 p. 288).[6] In Becker's theoretical universe, altruism serves as an effective disciplining device. He suggested that the Rotten Kid Theorem can explain why a parent delays some contributions to their children to later stages in life, or even after the parent's death, so as to provide a long run incentive for the children to consider the interests of the family as a whole (ibid p. 293). Another property of the "effective altruist"-approach is that as long as the altruist remains effective, intra-household distribution of goods is invariant to intra-family income distribution. This is in line with the unitary model and the *income pooling hypothesis*, a model which takes the family as a single decision making unit in the market. Although complete income pooling has been largely rejected in the

[4] For an amusing example read *The economics of brushing teeth* (Blinder 1974).
[5] "I remember giving a paper on economics and population at a conference in 1957 and people laughing at me." (Becker in interview with Richard Thompson, published in The Independent online October 18th 1992)
[6] A corollary of the theorem is that a beneficiary who is envious of other beneficiaries will maximize family income and thereby help those envied.

empirical literature, Becker's arguments have given name to a particular kind of "local" income pooling known as "Becker-regions". This will be formally presented in section 3.3.3.

2.3 Further developments

Becker's ideas have been criticized along many lines, among which are obscuring power relations within the family (Grapard 1999 p. 550), ignoring the possibility of endogenous preferences (Pollak 2002 p. 10) and being "fatally simplistic" (Bergmann 1996 p. 9). Many economists found the 'family consensus' and the 'effective altruism' approaches inadequate, and in the 1980's several efforts were made at modelling family behaviour with multiple decision makers having (partly) conflicting interests. Manser and Brown (1980) and McElroy and Horney (1981) were among the first to apply cooperative game theory to marriage (Lundberg and Pollak 2008). At the core of this approach lies the idea that each spouse can revert to a non-cooperative outcome if the result of cooperation is unsatisfactory. This non-cooperative utility level is referred to as a "threat point" and may stem from an outside option typically taken to be divorce (Manser and Brown 1980; McElroy and Horney 1981) or an inside option i.e. non-cooperation within marriage (Lundberg and Pollak 1993; Bergstrom 1996). The threat points, which may depend on a range of factors, affect bargaining power within marriage and hence the final outcome.[7] An important implication of these models is that if the distribution of income affects the threat points, it also affects the outcome and hence well-being for the husband and wife respectively. This stands in stark contrast to the income pooling hypothesis.

Another type of models is the "collective" approach first introduced by Chiappori (1988). The defining property of these models is that outcomes are assumed to be Pareto efficient. Instead of modelling a specific bargaining process, Chiappori shows that given a set of assumptions, the collective model is equivalent to the existence of a sharing rule. First, family income is allocated between public goods and each spouse's private spending. Second, the spouses maximize their own private utility given their respective budget constraints. The size of each spouse's share depends on a range of distributive factors that reflect bargaining power in the family. The efficiency assumption imposes testable restrictions on behaviour, among which are symmetrical responses in household demand to changes in distribution factors that affect the sharing rule (Ermisch 2003 p. 27).

[7] Nash-bargaining is the most commonly used bargaining process in these models (Lundberg and Pollak 2008)

Other types of models include pure non-cooperative models (Ulph 2006) and intertemporal models (Bergstrom 1996; Lundberg and Pollak 2003). These typically allow outcomes to become inefficient through non-cooperative behaviour in the provision of public goods and/or past decisions leading to an inefficient outcome in later periods. Due to the fact that I am using cross-sectional data, a discussion of intertemporal models is not part of this thesis.[8]

[8] The data set is not strictly cross-sectional, because the observations in the sample are from five different quarters. For reasons explained in chapter 4, the time dimension in the data is ignored.

3 Theory and models

3.1 Overview

This chapter presents the theoretical framework that motivates the empirical analysis. Before introducing the actual models, however, I think it is useful to discuss some fundamental properties relating to preferences – and the corresponding glossary (section 3.2). The reason is that the type of preferences chosen for a model setting has important implications for the predictions of the model. Some of these implications are similar across different types of models. Furthermore, since economists differ in the terms they use to explain the same concepts, I think it is fruitful to explain the vocabulary I will be using.

The relevant models are presented in section 3.3. A key point of this exercise is to show how different models predict different expenditure patterns as functions of the wife's share of income – properties that lend themselves well to empirical testing. For reference, I start with the standard unitary model before I move on to the non-unitary models. The first of these is the non-cooperative model with egotistic preferences (section 3.3.2) where I demonstrate how this leads to income pooling for some distributions of household income, but not all. In section 3.3.3, I show how going from egotistic preferences to a kind of "caring" preferences (see section 3.2.2) changes the predicted spending pattern for heavily skewed income distributions.

A collective model is presented in section 3.3.4. A defining property of the collective model is that the outcome is assumed to be efficient, and the theoretical result here is used to demonstrate that the predicted outcome in the non-cooperative model is inefficient. A specific bargaining process, which the collective model lacks, is introduced in section 3.3.5. The model is a Nash-bargaining model where the non-cooperative outcome in section 3.3.2 forms the respective breakdown points. Along with the models I also show how family members' basic preference structure has implications for the predicted outcomes.

3.2 Preferences (and some semantics)

Microeconomic theory often assumes that preferences are stable and exogenous. This has been challenged in various contexts (Bowles 1998), among which is family behaviour (Pollak 2002). It is beyond the scope of this thesis to provide a full discussion of this, apart from noting that it seems reasonable to treat preferences as exogenous in the non-intertemporal framework I will be using.

Another (sometimes implicit) assumption often present in microeconomic theory is that preferences are egotistic, i.e. that only an individual's private consumption is present in the individual's utility-function. This might be a reasonable assumption in a market context, but not necessarily so in a family context. It is common to assume that at least some family members care about the welfare of other family members, and this interdependency of preferences is formulated in various ways in the literature. Regardless of model and/or objective function, interdependency of preferences usually has important implications for the theoretical outcome.

On the general level, exogenous preferences in the family context can be divided into three broad categories. Unfortunately, there is no common agreement among authors about which terms should be used to refer to which category. This subsection is included to explain the vocabulary I will be using – and to alleviate any potential confusion.

3.2.1 Egotistic preferences

This is the standard specification used in countless expositions in economics. For two people, a husband and a wife, this could be formulated as:

$$U^h = v^h\left(\boldsymbol{x}_h, \boldsymbol{G}\right)$$
$$U^w = v^w\left(\boldsymbol{x}_w, \boldsymbol{G}\right)$$

Here, $\boldsymbol{x}_i$ are vectors of private goods and $\boldsymbol{G}$ is a vector of public goods. Preferences for both individuals are defined over private consumption only, and no other individual's consumption enters the respective utility functions (insofar as external effects that could be included in the *G*-vector). A corollary of this is that an individual's total utility and private utility (the *v*-function) effectively become the same. Some authors use the term "egoistic" instead of "egotistic", but I prefer the latter so as to distinguish the term from psychological egoism. I

see the term "egotistic" as a matter of semantic convenience rather than a theory of human nature as such.

3.2.2 Deferential preferences

Deferential preferences refer to a type of interdependent preferences that can be described in the following way: The individual cares about at least one other person's utility but not how it is actually obtained. Following the husband and wife example from before, the general specification is:

$$U^h = \psi^h\left(v^h\left(\boldsymbol{x}_h, \boldsymbol{G}\right), v^w\left(\boldsymbol{x}_w, \boldsymbol{G}\right)\right)$$
$$U^w = \psi^w\left(v^w\left(\boldsymbol{x}_w, \boldsymbol{G}\right), v^h\left(\boldsymbol{x}_h, \boldsymbol{G}\right)\right)$$

Each spouse has a private utility function defined over private consumption, but also an aggregator function that resemble a Bergson-Samuelson welfare function (Varian 2006 p. 620). One crucial point to be made about this specification is that it involves no preferences about the composition of other people's consumption bundles. In the family context, this might seem somewhat counterintuitive (Ermisch 2003 p.47). For instance, it is not unreasonable to assume that a wife cares about how her husband dresses, or that she is not indifferent to whether he gets his utility from smoking or jogging. The reason why this kind of preferences is popular among family economists is that they impose testable restrictions on the outcomes of family decision making (Ermisch 2003 p. 27).

The familiar reader might recognize this preference structure as "caring" (Browning et al 2001 p. 19) or "altruistic" (Becker 1991 p. 278). My use of the term "deferential" follows Pollak (2002) who argues that "altruistic" conflicts with ordinary usage of the term and causes confusion with non-economists. For instance, if a wife thinks her husband should spend more time at the gym and less time in front of the television because she thinks it's good for him, it would probably coincide with most people's conception of "caring". In this context, however, that would violate the specification at hand. The term "deferential" refers to the fact that the husband defers to the wife's preferences regarding her consumption and vice versa. In Pollak's view, and I follow his argument, this is a more precise terminology.

3.2.3 Non-deferential preferences

Non-deferential preferences exhibit the highest degree of interdependency between spouses:

$$U^h = v^h\left(\boldsymbol{x}_h, \boldsymbol{x}_w, \boldsymbol{G}\right)$$
$$U^w = v^w\left(\boldsymbol{x}_w, \boldsymbol{x}_h, \boldsymbol{G}\right)$$

Here, the husband and the wife have preferences about the specifics of the spouse's consumption. Ermisch (2003 p. 31) refer to these as "altruistic" preferences, but they could just as well be seen as "paternalistic" depending on the motivations of the individual. This is why I think Pollak (2002) makes a valid point when he argues that "non-deferential" is a more precise term. Non-deferential preferences are perhaps the most intuitively appealing preference structure when it comes to families, both when it comes to spouses caring for each other and parents caring for their children. But for modelling purposes, they lack some of the advantages of deferential preferences (Browning et al 2011 p. 104). One reason is that with non-deferential preferences, all goods effectively become public goods and researchers can impose fewer testable restrictions on the models. For example, a setup with deferential preferences allows for testing whether a good is a household public good or not, whereas a setup with non-deferential preferences does not.

3.3 Taxonomy of models

Economic models of family behaviour can broadly be divided into unitary and non-unitary models. Unitary models treat the family as if it were a single decision making agent, whereas non-unitary models do not. What sets the latter apart from the former is the emphasis that is put on the intra-family decision process. In the unitary model, the decision process is simply assumed away (see section 3.3.1), and the family is modelled as if there exists a single "family utility function" and a pooled "family resource constraint". Analogous to "the firm" in standard microeconomic theory, "the family" is treated as a single decision making agent and what goes on inside the family is hidden in the "black box".

In contrast, non-unitary models treat the decision process itself as important for the final outcome. In this process, individuals typically use their respective endowments according to their own agenda which may be more or less "altruistic" (see section 3.2 about preferences). Non-unitary models can again be broadly divided into cooperative and non-cooperative models. Both allow for interests to be conflicting, but there is a key difference when it comes to efficiency. In cooperative models there is generally the assumption that the outcome is Pareto efficient, and the conflicts of interests translate into deciding which of the possible efficient outcomes are realized. In non-cooperative models there is no such assumption, and the outcome is often Pareto-inefficient, particularly with respect to the provision of public goods.

3.3.1 The Unitary Model

The unitary model of family behaviour can be traced back to (at least) Paul A. Samuelson's paper *Social Indifference Curves* from 1956. As the title suggests, the paper was not solely about family economics, but his discussion of "group demand" led to a discussion of how "family demand" is formed (Samuelson 1956 p. 8). Samuelson dismissed the idea that stable family preferences could stem from one family member having sovereign power within the family, noting that any casual anthropologist would find this at odds with modern Western culture. He did, however, find it less unrealistic to adopt a hypothesis of a stable and consistent family consensus that in turn would lead to a demand system that did not violate standard regularity conditions – although he somewhat jokingly added: "Perhaps Arrow might prove such a consensus to be impossible" (ibid p. 9). Becker, on the other hand, argues that an

"effective altruist" who is making intra-family transfers can give rise to a "family utility function" (Becker 1991 p. 296). This person is (by other authors) sometimes referred to as a "Becker-dictator", even though Becker emphasizes that the altruist does not have dictatorial powers over the other family members' decisions (ibid).

Standard economic textbooks typically abstain from elaborating on the rationale behind the unitary model, they simply adopt it. A typical example of this can be found in Cowell (2005) who in the chapter about the consumer and the market writes that "Obviously, too, we could translate all this from the case where the consumer is an individual to that where the consumer is a household." (Cowell 2005 p. 100). A simple form of the model with only a husband and a wife, no public goods and no saving, can be written as:

$$\max \; U\left(c^h, c^w\right) \quad \text{subject to} \quad p^h c^h + p^w c^w = Y^h + Y^w \equiv Y$$

Here, the superscripts *h* and *w* represent husband and wife respectively. *Y* is income, *c* is consumption and *p* is the price of that consumption. Solving the maximization problem would yield demand functions of the form:

$$c^i = D\left(p^h, p^w, Y\right) \qquad i = h, w$$

A central feature of this approach is the income pooling hypothesis which is the idea that only total family income matters and that the source of income is irrelevant. Formally, since $dY^h = dY^w$, we have:

$$\frac{\partial U}{\partial Y^h} = \frac{\partial U}{\partial Y^w} \quad , \quad \frac{\partial c^i}{\partial Y^h} = \frac{\partial c^i}{\partial Y^w}$$

This means that the marginal family utility of income is independent of the sources of income, and so is the marginal demand for each of the two spouses. The unitary model can be extended in a number of ways to include for instance labour supply and intra-family public goods. Individual utility functions can be included in the family utility function as long as their respective weights are constant. As an example, the following model is considered unitary:

$$\max \ W=\mu U^h\left(\boldsymbol{c}^h,\boldsymbol{G}\right)+\left(1-\mu\right)\mathrm{U}^w\left(\boldsymbol{c}^w,\boldsymbol{G}\right) \qquad 0\le\mu\le 1$$

$$\text{s.t.} \quad \boldsymbol{p}\left(\boldsymbol{c}^h+\boldsymbol{c}^w+\boldsymbol{G}\right)=\sum_{i=1}^{n} p_i\left(R_i-c_i\right)$$

Now, the $\boldsymbol{c}$'s represent private consumption vectors and $\boldsymbol{G}$ a vector of intra-family public goods. The price vector $\boldsymbol{p}$ captures all relevant prices. The right hand side of the budget constraint is the value of all household resources, such as time that can be "sold" in the market, minus the resources used for consumption (such as time spent as leisure). The key assumption of income pooling still remains, and how the weight μ came about is irrelevant. On the other hand, if we allow μ to be endogenous and a function of for instance relative income, the model is no longer unitary.

3.3.2 A non-cooperative model with egotistical preferences

In this model, each spouse controls his or her own exogenous source of income, and from the outset there is therefore no income pooling. Cooperation between the spouses is absent in the sense that the husband and the wife each distribute their income between private spending and voluntary contributions to a public good, taking the spouse's contribution as given. In other words, they behave according to the definition of a Nash equilibrium (Nash 1951).

Intuitively, this model setup might seem a bit odd – at least in Western societies (Browning and Lechene 2001 p. 10).[9] If two people voluntarily agree to form a household, would it not be reasonable to expect some form of cooperation to take place? As pointed out by Ermisch (2003 p. 21), modelling non-cooperative behaviour is not the same as postulating that this is how families actually behave. And despite the apparent non-realism inherent in models of this kind, they do have some theoretical appeal. First, they could be interpreted as the fallback position for family members if communication and/or cooperation were to break down.[10] After all, the sheer number of marriage counsellors and divorce lawyers suggests that simply forming a household does not a happy cooperative make. Second, the non-cooperative models serve as a point of departure from which the gains from cooperating can be illustrated and estimated.

[9] See section 3.5 for empirical evidence from Africa in favour of non-cooperative models.
[10] See section 3.3.5 for an example of a bargaining model that uses the non-cooperative outcome as the basis for the breakdown points.

The following example will to a large extent follow Ermisch (2003) and is simplified for ease of exposition. This does not affect the general properties of the model (Browning and Lechene 2001; Ulph 1996). Assume a two person household consisting of a husband and a wife. For simplicity, assume only two goods; one pure private good, *x*, and one pure public good, *G*. Let preferences be of the egotistic type with log-linear utility:

$$U^i\left(x_i, G\right) = \alpha_i \ln\left(x_i\right) + \left(1-\alpha_i\right)\ln G \qquad G = g_1 + g_2 \quad i = h, w \tag{3.1}$$

The α-parameter represents the weight each spouse puts on the private good relative to the public good. Now assume that the couple does not cooperate, and instead maximizes his/her welfare taking the other spouse's contribution to the public good as given. Each spouse solves:

$$\begin{aligned} &Max\, U^i\left(x_i, g_i + g_j\right) = \alpha_i \ln\left(x_i\right) + \left(1-\alpha_i\right)\ln\left(g_i + g_j\right) \\ &s.t.\;\; p_x x_i + p_g g_i = y_i \;\; and \;\; g_i + g_j = G \qquad\qquad i, j = h, w \quad i \neq j \end{aligned} \tag{3.2}$$

The maximization problem will yield the following demand functions for the public good:

$$\begin{aligned} g_h &= \frac{\left(1-\alpha_h\right) y_h}{p_g} - \alpha_h g_w \\ g_w &= \frac{\left(1-\alpha_w\right) y_w}{p_g} - \alpha_w g_h \end{aligned} \tag{3.3}$$

The demand functions resemble standard Cobb-Douglas demand functions with fixed budget shares for each good with the addition that the spouse's contribution enters the demand function. For expositional ease, we can use the private good as the numeraire and then divide the public good into appropriately sized units so that the relative price can be normalized to unity. Then (3.3) can be rewritten as:

$$\begin{aligned} g_h &= \left(1-\alpha_h\right) y_h - \alpha_h g_w \\ g_w &= \left(1-\alpha_w\right) y_w - \alpha_w g_h \end{aligned} \tag{3.4}$$

For the husband, his contribution to the public good is increasing in his income, decreasing in the weight he puts on the private good and his wife's contribution to the public good – and similarly for the wife. The demand functions in (3.4) are essentially "reaction functions" that describe the utility-maximizing level of contribution to the public good for any level of the

spouse's contribution. If both contribute to the public good, the equilibrium solutions will be where these reaction functions intersect. From the husband's reaction function, we see that:

- If the husband does not contribute, the wife will supply $(1-\alpha_w)\, y_w$.
- In order to *make* the husband not contribute, the wife must supply $\dfrac{(1-\alpha_h)\, y_h}{\alpha_h}$.

So if $(1-\alpha_w)\, y_w < \dfrac{(1-\alpha_h)\, y_h}{\alpha_h}$, the husband will contribute to the public good. A similar argument can be made for the wife's contribution, and the equilibrium solution can be illustrated graphically as in Figure 1:

Figure 1: Equilibrium between non-cooperative reaction functions

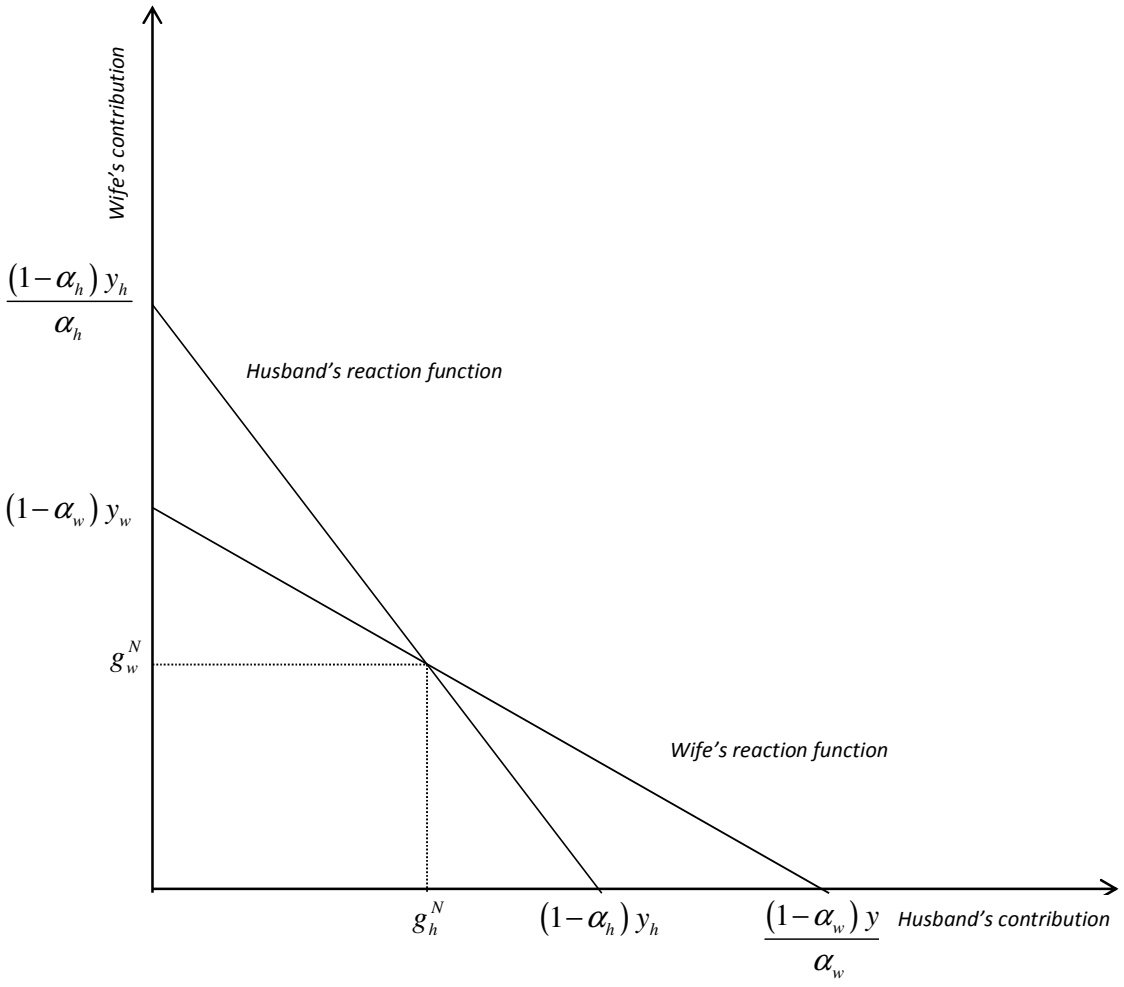


Figure 1 illustrates the couple's individual reactions functions in (3.4). The reaction functions are decreasing functions of the other household member's contribution to the public good. The point of intersection determines each spouse's contribution, and the equilibrium solution is:

$$g_h^N = \frac{(1-\alpha_h)\, y_h - \alpha_h (1-\alpha_w)\, y_w}{(1-\alpha_h \alpha_w)}$$
$$g_w^N = \frac{(1-\alpha_w)\, y_w - \alpha_w (1-\alpha_h)\, y_h}{(1-\alpha_h \alpha_w)} \tag{3.5}$$

Total contribution to the public good is simply $g_h + g_w$, and is equal to:

$$G^N = \frac{(1-\alpha_h)(1-\alpha_w)(y_h + y_w)}{(1-\alpha_h \alpha_w)} \tag{3.6}$$

This is the non-cooperative level of the public good when both spouses contribute. As is evident from (3.6), only total income matters and any (small) redistribution of income will not change the outcome. This is often referred to as "local income pooling". But will they both contribute? From the husband's equilibrium condition in (3.4) we see that he will not contribute if:

$$\frac{y_h}{y_h + y_w} \leq \frac{\alpha_h (1-\alpha_w)}{1-\alpha_h \alpha_w} \tag{3.7}$$

So if the husband's income relative to that of his wife is "too low" he will not contribute to the public good. This is because his marginal rate of substitution between the public good and the private good is lower than the relative price of the public good. This happens if his income is "small" or if he puts a sufficiently higher weight on the private good relative to what his wife does. If this is the case, the solution is simply $G^N = g_w = (1-\alpha_w)\, y_w$.

Figure 2: Non-equilibrium between non-cooperative reaction functions

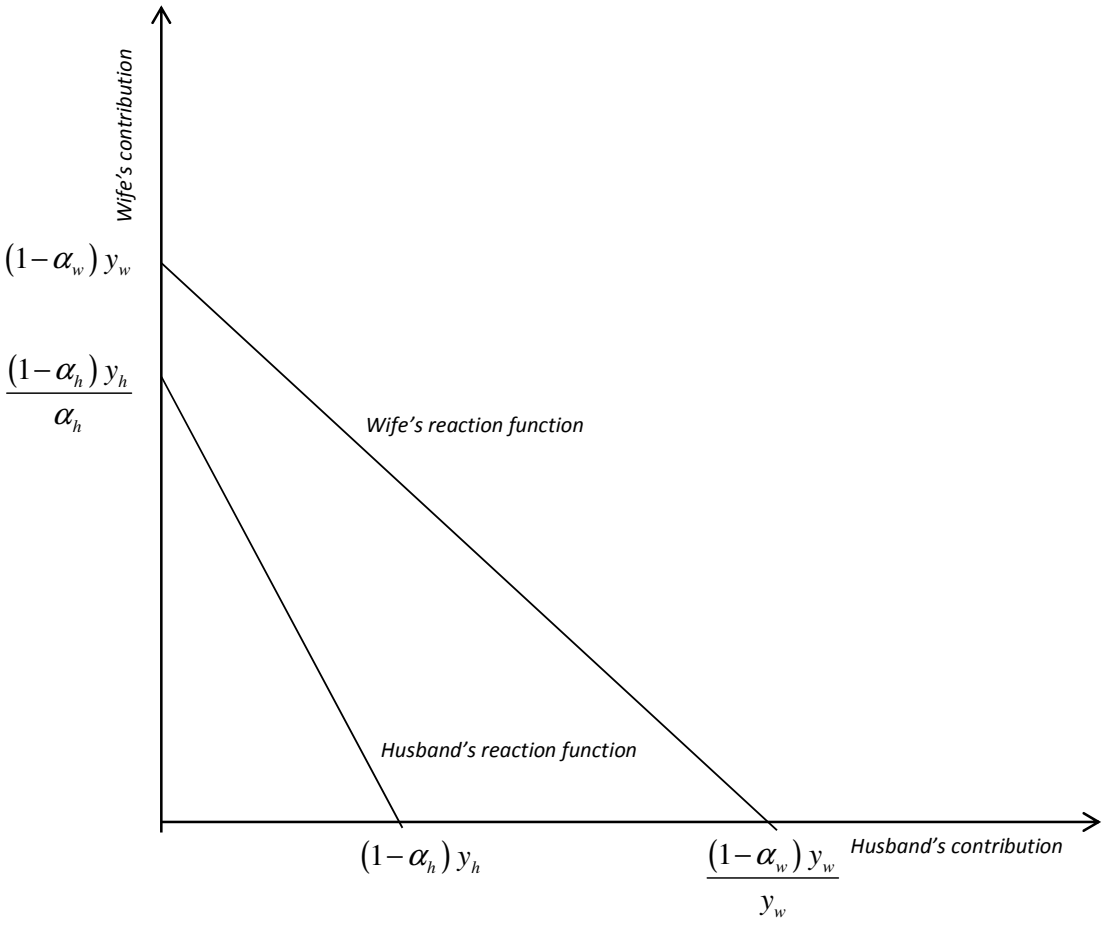
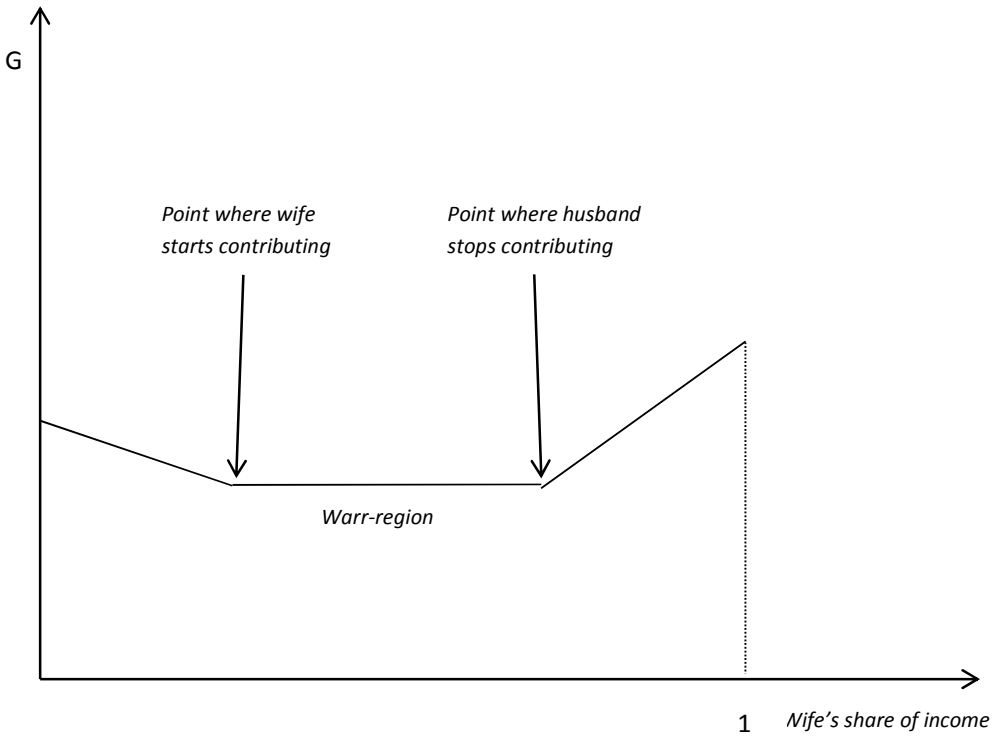


Figure 2 illustrates a situation where the husband is "too poor" to contribute to the public good. When the strict inequality in (3.7) holds, redistributing income from the wife to the husband will reduce her spending on the public good and increase his spending on the private good. That means that (local) income pooling no longer holds. Conversely, the wife will not contribute when:

$$\frac{y_h}{y_h + y_w} \geq \frac{(1-\alpha_w)}{1-\alpha_h\alpha_w} \tag{3.8}$$

So for (local) income pooling to hold, the spouses' relative income cannot be too different, and neither can their preferences be.

Figure 3: Non-cooperative household demand for the public good as function of the wife's share of income



An important property of this non-cooperative model is that household demand for the public good is effectively a function of relative income. This is illustrated in Figure 3, where the wife's share of (constant) household income is the independent variable. The leftmost point of the graph illustrates household demand when the husband controls all income. As income is transferred to the wife (moving to the right) the husband reduces his spending on the public good and the wife increases her spending on the private good. This process goes on until the wife's marginal utility from spending on the public good is equal to her marginal utility from spending on the private good. In the figure, this corresponds to the first kink point in the graph from the left. In the following flat section, the result from (3.6) holds and there is local income pooling. This means that as income is transferred to the wife, she increases her contribution to the public good and the husband reduces his. Their actions exactly offset each other so that household demand for the public good is unchanged until the husband's share of income becomes so low that he stops contributing to the public good. The flat segment in the middle of the graph is often referred to as a "Warr-region". This is a reference to the result in Warr (1983) that states that if a group of individuals are all voluntarily contributing to a

public good, small redistributions of income will not change the allocation of neither public nor private goods.

In Figure 3 I have assumed that the wife puts a relatively higher weight on the public good than what the husband does. This means that when she controls all income, household demand for the public good will be higher than when the husband controls all income. The assumption is merely illustrative here, but will become more important for models that will be discussed later.

In the above example, the outcome is inefficient except for in the extreme cases where either the husband or the wife receives all income. The inefficiency comes from the fact that higher contributions to the public good could make both spouses better off, and is the standard inefficiency result from private provision of public goods.

3.3.3 Introducing the Becker-region: A non-cooperative model with deferential preferences

The non-cooperative model I will present here is the same model as the previous with one important exception, namely that the wife now has deferential preferences.[11] As will be shown, this opens the possibility of the wife making voluntary transfers to her husband. This in turn leads to properties which can be transferred to other models as well.

As before, assume a two-person household where income is spent on either a private or a public good. The husband has egotistic preferences and the wife has deferential preferences as described in section 3.2:

$$\begin{aligned} U^h &= v^h\left(x_h, G\right) \\ U^w &= \psi^w\left(v^w\left(x_w, G\right), v^h\left(x_h, G\right)\right) \end{aligned} \tag{3.9}$$

This preference structure means that the wife cares about her husband's utility, but not about the composition of her husband's consumption bundle. Deferential preferences of this kind imply that according to the wife's own evaluation of her utility, income could be better spent on her husband rather than herself.

[11] If it were the husband who had deferential preferences, the analysis would be symmetrical. I will also show cases where both husband and wife have deferential preferences.

For expositional convenience[12], assume the same logarithmic utility as before and that the wife has a Ψ-function that simply puts a weight β on the husband's utility:

$$\begin{aligned} U^h &= \alpha_h \ln x_h + (1-\alpha_h)\ln(g_h + g_w) \\ U^w &= \alpha_w \ln x_w + (1-\alpha_w) + \beta\left[\alpha_h \ln x_h + (1-\alpha_h)\ln(g_h + g_w)\right] \end{aligned} \tag{3.10}$$

Since there is still no cooperation, both maximize their utility taking the partner's contribution to the public good as given. As before, both prices are set to unity. Since there is the possibility of a transfer (t), the husband's budget constraint is $x_h + g_h = y_h + t$ and the wife's budget constraint is $x_w + g_w = y_w - t$. Since only the wife has deferential preferences, we must have $t \geq 0$. Maximization yields the following reaction functions:

$$\begin{aligned} g_h &= (1-\alpha_h)(y_h + t) - \alpha_h g_w \\ g_w &= \left(\frac{1-\alpha_w + \beta(1-\alpha_h)}{1+\beta(1-\alpha_h)}\right)(y_w - t) - \frac{\alpha_w}{1+\beta(1-\alpha_h)} g_h \end{aligned} \tag{3.11}$$

Nothing here says anything about what the transfer, if any, will be. Solving for equilibrium of the two functions, we get:

$$\begin{aligned} g_h^{Nt} &= \frac{(1-\alpha_h)(1+\beta(1-\alpha_h))(y_h + t) - \alpha_h(1-\alpha_w + \beta(1-\alpha_h))(y_w - t)}{1+\beta(1-\alpha_h) - \alpha_h\alpha_w} \\ g_w^{Nt} &= \frac{(1-\alpha_w + \beta(1-\alpha_h))(y_w - t) - \alpha_w(1-\alpha_h)(y_h + t)}{1+\beta(1-\alpha_h) - \alpha_h\alpha_w} \end{aligned} \tag{3.12}$$

And for household demand for the public good:

$$g_h^{Nt} + g_w^{Nc} = G^{Nt} = \frac{(1-\alpha_h)(1-\alpha_w + \beta(1-\alpha_h))(y_h + y_w + t - t)}{1+\beta(1-\alpha_h) - \alpha_h\alpha_w} \tag{3.13}$$

Obviously, the t's cancel out, but are left in the equation for illustrative purposes. Once again the result is that as long as both are contributing to the public good, there is local income pooling (a Warr-region). When this happens, transfers don't really matter but will nevertheless be zero (see appendix D). So the question remains: When will there be transfers? When the husband is the only person contributing to the public good, there will by definition

[12] The following results do not rely on using log-utility functions. Browning and Lechene (2001) use more general utility functions to derive the Becker-regions. Using log-utility, however, enables the use of illustrative examples. See appendix D for an elaboration using the more general approach.

be no transfers since he has egotistical preferences. But if the wife is the only one contributing, she will transfer income to her husband if his income is sufficiently low.

From (3.12), we know that the husband will not contribute to the public good when:

$$\frac{y_h}{y_h + y_w} \leq \frac{\alpha_h\left(1+\beta\left(1-\alpha_h\right)-\alpha_w\right)}{1+\beta\left(1-\alpha_h\right)-\alpha_h\alpha_w} \tag{3.14}$$

This is a necessary but not sufficient condition in order to cause the wife to make transfers. Inserting the budget constraints and differentiating the second line in (3.9) with respect to transfers (see appendix D) will yield a first order condition that can be rearranged to:

$$\psi_h^w\left(v_x^h - v_G^h\right) - \psi_w^w v_G^w > 0 \tag{3.15}$$

This says that in order for transfers to be positive, she must value his utility gain from receiving money more than she values her own private utility loss from giving the money up. Transferring income to the husband means reduced spending on the public good from which they both will lose. But the husband will be better off, because he will spend the transfer on the private good and his marginal utility from the private good is higher than that from the public good (that is the reason he is not contributing to the public good in the first place). This means that the expression inside the parenthesis in (3.15) is positive. When her husband is better off, the wife is by definition better off because she has deferential preferences. But in order for transfers to be positive, this effect must more than offset her private utility loss from reduced spending on the public good. So how low must the husband's share of household income be for this to happen? When he is not contributing to the public good, we have:

$$G^{Nc} = g_w^{Nc} = \frac{1-\alpha_w+\beta\left(1-\alpha_h\right)}{1+\beta\left(1-\alpha_h\right)}\left(y_w - t\right)$$

$$x_h = y_h$$

Using (3.10), working through the differentiation in (3.15) and solving yields:

$$\frac{y_h}{y_h + y_w} < \frac{\alpha_h\beta}{1+\beta} \tag{3.16}$$

To confirm that this is actually a smaller fraction than that in (3.14), note that:

$$\frac{\alpha_h\left(1+\beta\left(1-\alpha_h\right)-\alpha_w\right)}{1+\beta\left(1-\alpha_h\right)-\alpha_h\alpha_w}-\frac{\alpha_h\beta}{1+\beta}=\frac{\alpha_h\left(1-\alpha_w\right)\left(1+\beta\left(1-\alpha_h\right)\right)}{\left(1+\beta\right)\left(1+\beta\left(1-\alpha_h\right)-\alpha_h\alpha_w\right)}>0$$

When the husband's relative income drops below the level in (3.16), the wife starts transferring money to him to keep his utility at what she perceives as the "minimum" level. So when the relative income of the husband is between zero and the level in (3.16) there is local income pooling and she behaves as an "effective altruist" towards her husband.

Figure 4: Non-cooperative household demand for the public good when the wife has deferential preferences

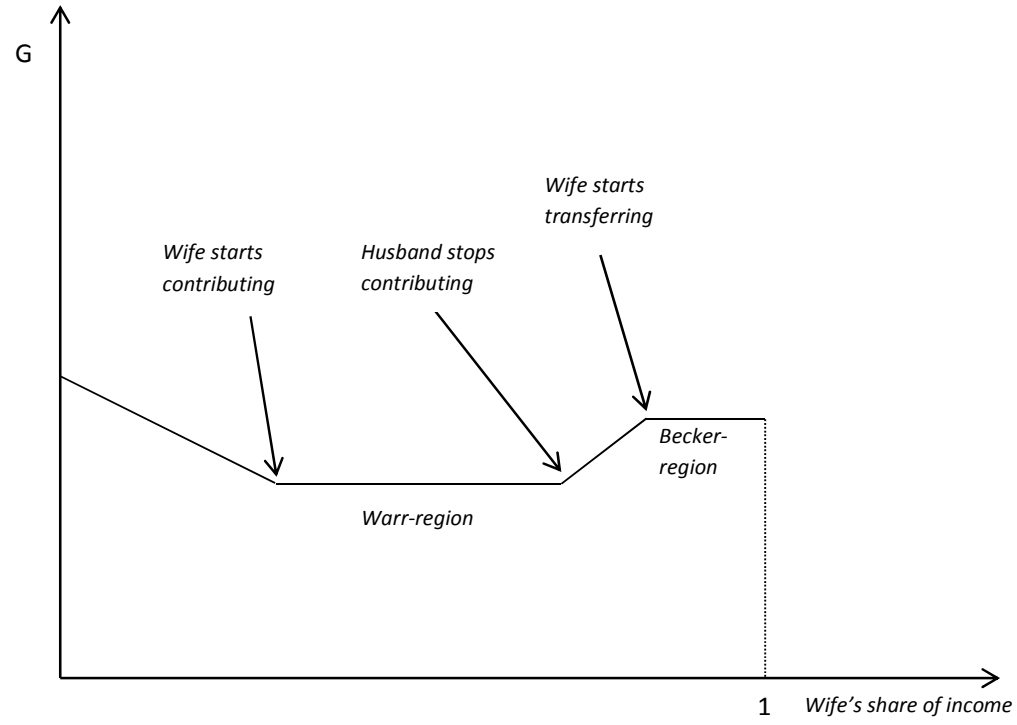


Figure 4 shows household demand for the public good as a function of the wife's share of income. Compared to the non-cooperative model with egotistical preferences only, there is a flat region to the right in the diagram. This is the result of transfers from the wife to the husband. It is often referred to as a "Becker-region" in recognition of Gary Becker's argument that an effective altruist gives rise to income pooling. If both the husband and the wife have deferential preferences, another Becker-region would be added to the left in the figure. Note that even though the Becker-region and the Warr-region has similar properties when it comes

to outcomes, the rationales behind them are fundamentally different. The Warr-region is a result of strategic and "selfish" behaviour, whereas the Becker-region is a result of caring or "altruism".

3.3.4 The collective model

If we now allow the couple to communicate and cooperate, the decision process changes significantly. In the context of the collective model, this means that it is assumed that the final outcome is efficient, i.e. it is not possible to make one spouse better off without making the other worse off. With egotistic preferences, this can be formalized as:

$$Max\, U^h\left(x_h, G\right) \quad \text{subject to} \quad U^w\left(x_w, G\right) \geq \bar{U} \quad \text{and} \; p_x\left(x_h + x_w\right) + p_g G = y_h + y_w \tag{3.17}$$

With normally behaved utility-functions, the utility constraint holds with equality. The maximization problem leads to the following first order conditions:

$$\begin{aligned} U_x^h &= \mu\, U_x^w \\ \frac{U_G^h}{U_x^h} + \frac{U_G^w}{U_x^w} &= \frac{p_g}{p_x} \end{aligned} \tag{3.18}$$

μ is the Lagrange multiplier associated with the utility constraint and is the shadow value for the husband of reducing his wife's utility, i.e. relaxing the first constraint in (3.17). The second line is the standard condition for the optimal provision of public goods, namely that the sum of the marginal rates of substitution should equal the relative price of this good. If we use the same log utility-functions as in (3.1), we can solve for the demand functions:

$$\begin{aligned} G^e &= \frac{1}{p_g}\left(\frac{\left(1-\alpha_h\right)}{1+\mu} + \frac{\mu\left(1-\alpha_w\right)}{1+\mu}\right)\left(y_h + y_w\right) \\ x_h^e &= \frac{\alpha_h\left(y_h + y_w\right)}{1+\mu} \qquad x_w^e = \frac{\alpha_w \mu\left(y_h + y_w\right)}{1+\mu} \end{aligned} \tag{3.19}$$

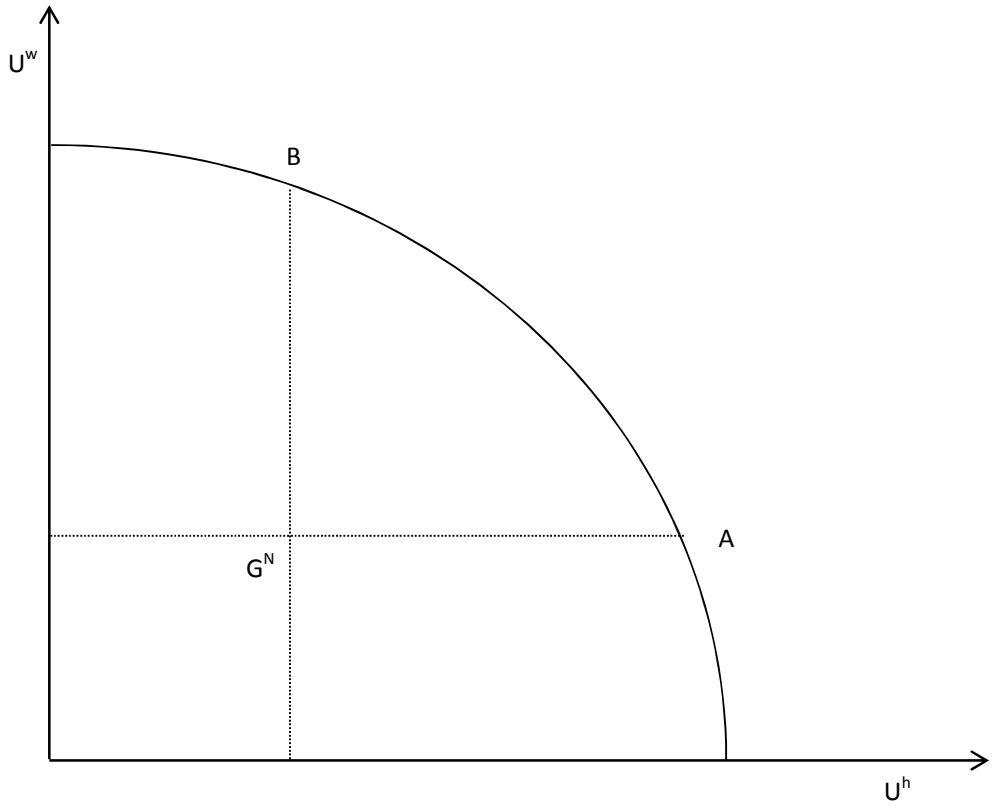
A property of these demand functions is that the spouses behave as if they are each given a share of joint income, $\frac{1}{1+\mu}$ and $\frac{\mu}{1+\mu}$ respectively, and then independently allocate their resources between the private and the public good. It is as if there is an income sharing rule stemming from the relative weight each spouse's utility is given (Ermisch 2003 p. 27).

If we momentarily assume that the husband and the wife have the same preferences, $\alpha_1 = \alpha_2 \equiv \alpha$, comparing (3.6) with (3.19) yields:

$$\frac{G^e}{G^N} = \frac{\left(\frac{(1-\alpha)}{1+\mu} + \frac{\mu(1-\alpha)}{1+\mu}\right)(y_h + y_w)}{\frac{(1-\alpha)(1-\alpha)(y_h + y_w)}{(1-\alpha\alpha)}} = 1 + \alpha > 1 \qquad (3.20)$$

This confirms that the non-cooperative level of the public good is inefficient.

Figure 5: Comparison of the collective model and the non-cooperative model



The curve in Figure 5 is called the "utility possibilities frontier". It represents all possible efficient outcomes from (3.17) and is traced out by varying the Pareto weight. The non-cooperative equilibrium from (3.6) is inserted as an illustration of an outcome that is inefficient – it is located "inside" the frontier. At the core of the collective model lies the prediction that the couple will end up somewhere on the utility possibilities frontier, i.e. that the outcome is efficient. What it does not say, however, is which point will actually be chosen. Although the basic collective model does not explicitly make any reference to a non-cooperative solution, the latter could still be used in a thought experiment that would render certain elements of the locus more probable to contain the solution than do others. The husband is not likely going to accept a point to the left of point B, seeing as he then would gain from reverting to non-cooperation. Similarly, the wife will probably not accept a point to the right of point A. From (3.19) it is clear that in this particular setup, the outcome depends on the μ-parameter. If the μ-parameter is constant, the model collapses to a unitary model. But if μ depends on exogenous factors and/or is (partly) endogenous, the model is obviously not unitary.

One possible interpretation of μ is that it reflects bargaining power in the family. In general, μ may depend on a range of factors, such as relative income, divorce laws, marriage market attributes and social customs. In the literature, these are often referred to as "distribution factors" (Browning and Chiappori 1998; Browning and Lechene 2001) or "extra-environmental parameters" (McElroy 1990). From (3.19):

$$\frac{\partial G^e}{\partial \mu} = \frac{1}{p_g} \frac{\alpha_h - \alpha_w}{(1+\mu)^2} (y_h + y_w) \tag{3.21}$$

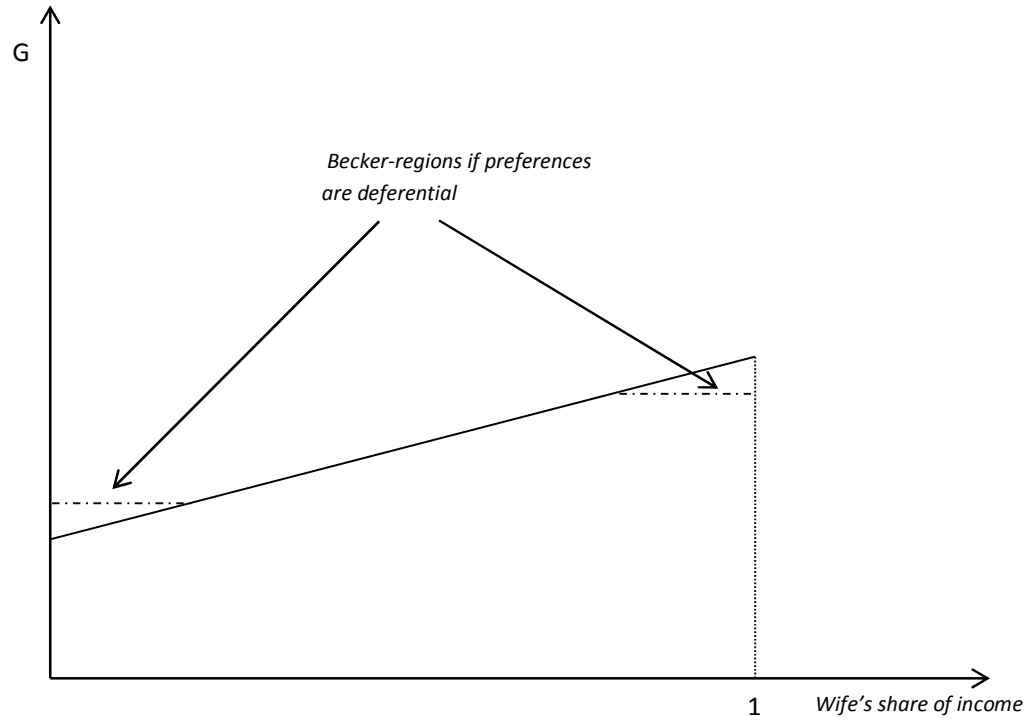
If preferences are different, $\alpha_1 \neq \alpha_2$, changes in bargaining power will affect spending on the public good. If preferences are the same, only private consumption will be affected by changes in μ. One factor of particular interest for empirical researchers is relative income, and it is common to assume that μ is increasing in this parameter. Denote ρ as the wife's share of income, $\frac{y_2}{y_1 + y_2}$, and θ as the share allocated to the wife, $\frac{\mu}{1+\mu}$. Then from (3.19) :

$$\frac{\partial G^e}{\partial y_2} = \underbrace{\frac{1}{p_g}\left[(1-\theta)(1-\alpha_h) + \theta(1-\alpha_w)\right]}_{\text{Income effect}} + \underbrace{\frac{1}{p_g}(\alpha_h - \alpha_w)(y_h + y_w)\frac{\partial \theta}{\partial \rho}\frac{\partial \rho}{\partial y_w}}_{\text{Bargaining effect}} \tag{3.22}$$

The interpretation is that an increase in the wife's income has two effects. First, it increases spending on the public good because total household income increases. Second, it increases the wife's bargaining power, and thereby her allocated share of total income. This may add to or offset the income effect, depending on her preferences. If $\alpha_1 - \alpha_2 > 0$, she prefers the public good more than her husband does and the bargaining effect will have the same sign as the income effect. If the opposite is the case, then the total effect on G will be lower than the income effect alone.

A central feature of a collective model like this one is that expenditure on the public good as a function of relative income is fundamentally different than that of the non-cooperative model, given that preferences are different and relative income is indeed a distribution factor:

Figure 6: Household demand for the public good in the collective model



In Figure 6, I have kept the assumption made earlier that $\alpha_1 - \alpha_2 > 0$ which means that the wife has the strongest preference for the public good. As her relative income increases, so does family spending on the public good. With egotistic preferences, household demand is

strictly increasing in relative income (the solid line). If the wife has deferential preferences such as in (3.9), a Becker-region will appear in the right of the diagram (the dotted line). If the husband has deferential preferences as well, another Becker-region will appear in the left of the diagram (see Browning and Lechene 2001 p.7). Efficiency resulting in an income sharing rule also holds when deferential preferences are present (Ermisch 2003 p. 29). If preferences are non-deferential, however, the income sharing rule interpretation no longer holds. In that case all goods effectively become public goods, and the difference between "his" and "her" spending is blurred.

3.3.5 Nash-bargaining models

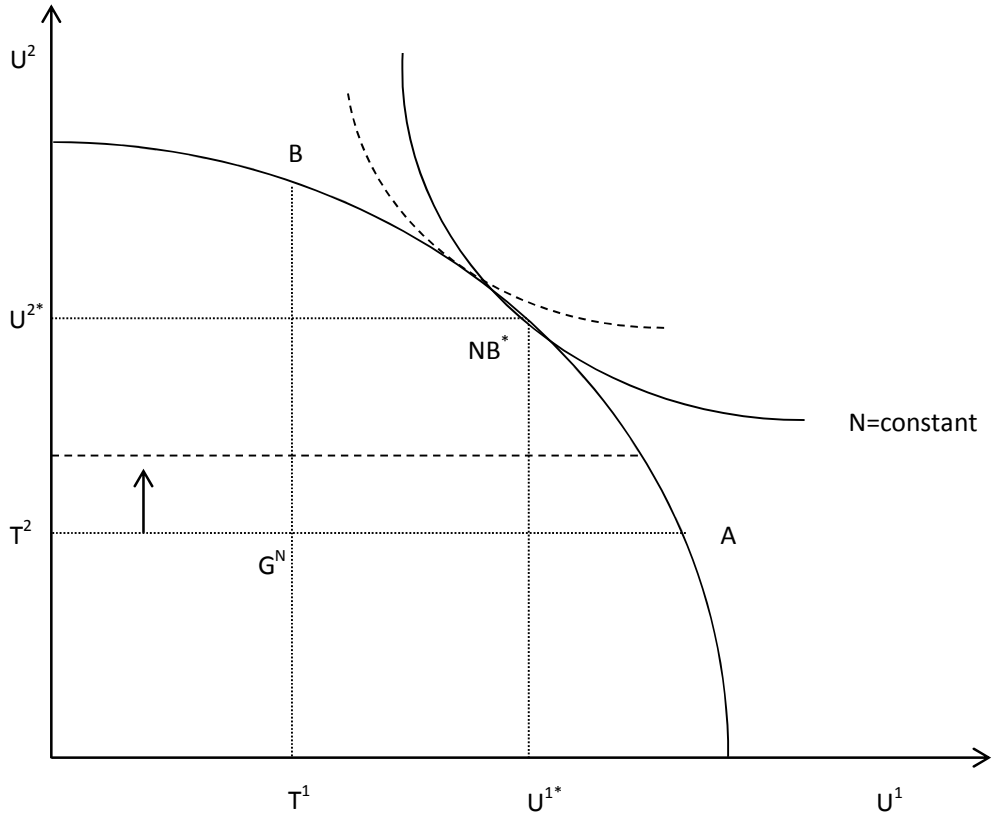
The standard collective model does not specify a detailed bargaining process other than saying that the Pareto weight depends on a range of distributive factors. If one specifies an explicit bargaining process, the model effectively becomes a bargaining model. A common variant is the Nash-bargaining model with a set of breakdown points known as "threat points". In this model, the couple is thought to maximize the product of the gains from cooperation, taking the respective utilities from non-cooperation as their threat points:

$$Max\, N = \left[U^h\left(x_h, G\right) - T^h\left(Z_h\right)\right]\left[U^w\left(x_w, G\right) - T^w\left(Z_w\right)\right] \tag{3.23}$$

The respective threat points depend on a range of factors included in the Z-vectors. Early formulations of this type of model used an outside option (divorce) as the threat points (Manser and Brown 1980, McElroy and Horney 1981). Other versions that have since been developed have taken the inside option as the threat point, that is non-cooperation within the marriage. An obvious difference is that a change in divorce laws or the marriage market may affect the outside threat point but usually not the inside threat point. Bergstrom (1996) argues that it is unlikely that a married couple resolve differences under the constant threat of divorce.[13] Following his argument, and using the non-cooperative utilities from section 3.3.2 as threat points, the solution can be represented by inserting an iso-product curve associated with the Nash function tangent to the utility possibility frontier:

[13] "If one spouse proposes a resolution to a household dispute and the other does not agree, the expected outcome is not divorce. A more likely outcome is harsh words and burnt toast, until the next offer is made." (Bergstrom 1996 p. 1926)

Figure 7: The Nash-bargaining model



In Figure 7, the utility possibilities frontier is the same as in Figure 5. The threat points are T^1 and T^2 respectively and stem from the non-cooperative solution. The outcome is at point NB^* which is Pareto efficient. A positive shift in the wife's threat point will shift the solution upwards and to the left as indicated by the dashed line and the dashed iso-product curve. A relevant question for this thesis is: In what way does going from the non-cooperative setting in 3.3.2 to a Nash-bargaining model with non-cooperative (inside) breakdown points change the demand for public goods as a function of relative income? The question can be answered with the help of a few intuitive arguments:[14]

[14] These arguments are based on Browning and Lechene (2001), but I have elaborated slightly to make them more specific and easier to follow.

1. In the Warr-region in the non-cooperative setting, the distribution of goods does not change as the distribution of income changes.

2. Therefore, the threat points do not change in the Warr-region.

3. That in turn means that the Nash solution does not change in the Warr-region since the Nash solution by definition is unique.

4. Hence, the Warr-region is "inherited" by the cooperative Nash-model.

Continuing the assumption that the wife has a relatively stronger preference for the public good than the husband does the following arguments will trace out the rest of the graph in Figure 8.

5. As the wife's share of total income decreases beyond the Warr-region in the non-cooperative setting, her utility decreases and the husband's increases.

6. Therefore her threat point in the Nash-model is weakened and his is strengthened.

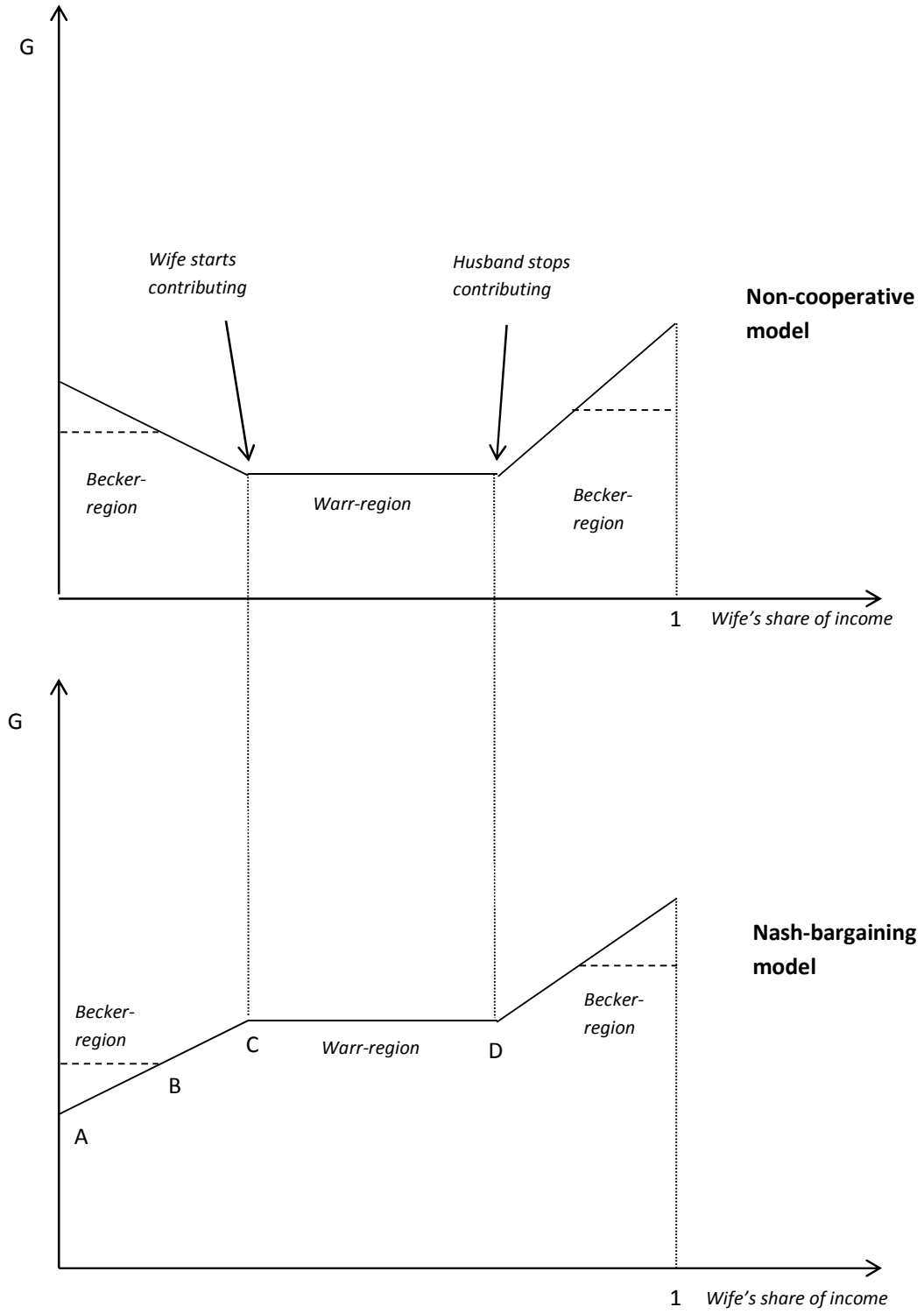
7. Given that the wife has a stronger preference for the public good, the demand for public good is reduced as her bargaining power is reduced.

8. Conversely, if the wife's share of total income increases beyond the Warr-region, the demand for the public good increases.

9. Any Becker-regions in the non-cooperative model are inherited by the Nash-model since local income pooling has the same non-effect on the threat points here as in the Warr-region.

Figure 8 shows the link between the non-cooperative model and the Nash-model with respect to household demand for the public good as a function of the wife's share of household income. The top panel is the non-cooperative model and the bottom panel is Nash-model. Starting from the left in the Nash-model, as her share of income increases (point A, the solid line), her threat point is strengthened so that she is able to push more spending on the public good according to her preferences. This happens because in the non-cooperative model, an increase in her share of income would have increased her utility from increased spending on the private good.

Figure 8: Household demand for the public good in the Nash-bargaining model with non-cooperative breakdown points.



If the husband would have made transfers when her income was "low" in the non-cooperative setting (the dashed line to the left in the top panel), her threat point would not change until she becomes "rich enough" for him to stop making transfers (where the dashed line ends at point B). In other words: Any Becker-regions are inherited by the Nash-model. As the wife's share of income increases beyond point B, she is able to increase household demand for the public good until her share of income is so large that she would have voluntarily contributed to the public good had there been non-cooperation (point C). As her share of income increases further, nothing happens to household demand for the public good until the point at which the husband would have stopped contributing to the public good in a non-cooperative setting (point D). This is because as long as the distribution of income stays within the non-cooperative Warr-region, the distribution of goods is unaffected by changes in relative income thereby leaving the threat points in the Nash model unchanged. Increasing the wife's share of income beyond point D would increase her threat point, however, because she would have more to spend on the private *and* the public good whereas as the husband would have less and less to spend on the private good.

3.4 Comparing the predictions of the various models

The different models I have presented predict different consumption patterns with respect to the household public good and intra-household distribution of income (assuming that control over a portion of household income is indeed a relevant distribution factor). Letting demand functions be linear is of course a significant simplification, but should still provide testable implications. Assuming as before that the wife has a stronger relative preference for the public good, household demand under the different setups can be schematically summarized as in Figure 9 (kink points are arbitrary).

Figure 9: Comparing the predictions of the various models.

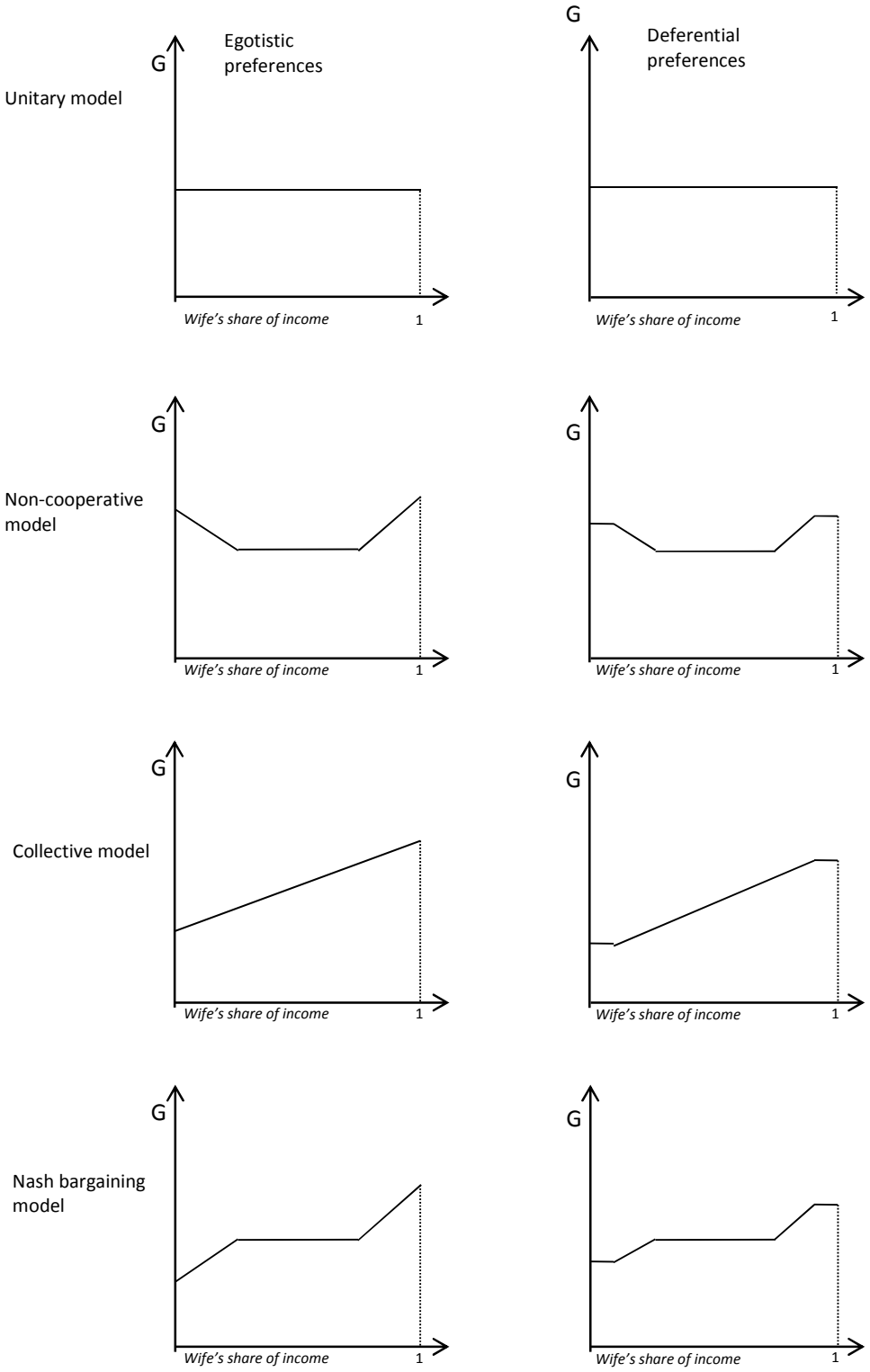


Figure 9 shows household demand as a function of the wife's share of household income (total income is constant) for the models previously presented. The left column shows the models where both the husband and the wife have egotistic preferences, the right column where they both have deferential preferences. Each model variant, insofar as the unitary model, predicts a different combination of flat and sloped segments. There are also differences between the combinations of signs on the slopes. For instance does the Nash-model have the same sign on both slopes while the non-cooperative model has opposite signs on the slopes. The actual signs depend on whether it is the husband or the wife that most strongly prefers the public good in question. Also note that although it is not explicitly included in Figure 9, there is the possibility that only one spouse has deferential preferences. This would mean that the model has only one Becker-region either to the left (husband deferential) or the right (wife deferential). A key point is that these patterns can be translated into testable restrictions which will be used for the empirical analysis.

3.5 Existing empirical evidence

The unitary model has been widely rejected in the empirical literature (Lundberg and Pollak 2008, Browning et al 2011 p. 227). Using data from five Canadian Family Expenditure Surveys, Browning (1995) finds that the household saving rate decreases with the wife's share of income (after accounting for many of the other influences on savings, such as age, household composition, education and occupation, but not household income). Phipps and Burton (1998) find that although income may be pooled for some categories of consumption (e.g. housing), the income pooling hypothesis is rejected for other categories. They also find effects in line with traditional gender roles, i.e. that expenditure on child care increases with women's incomes but not with men's. Another significant paper involves a "natural experiment" arising from a policy change in United Kingdom. Over the period 1977-1979, the Child Tax Allowance, which primarily went to the father, was replaced by a single Child Benefit paid directly to the mother. Lundberg et al. (1997) find a substantial increase in expenditures on women's and children's clothing relative to men's clothing following the policy change, something that should not have happened under the unitary model.

Results like these are not limited to countries with predominantly Western culture. Using expenditure data from Ethiopia, Bangladesh, Indonesia and South Africa, Quisumbing and Maluccio (1999) reject the unitary model for all countries, although to a varying degree. Their

results indicate that assets controlled by women have a positive and significant effect on expenditure allocations towards the next generation. Doss (2006) uses data from the 1991/92 and the 1998/99 Ghana Living Standards Survey and finds that women's share of farmland significantly increases budget shares on food. Schultz (1990) uses data from Thailand to reject the hypothesis that nonearned income of husband and wife has identical effects on family labour supply and commodity demands. Thomas (1990) uses Brazilian family data on health and nutrition and finds that unearned income in the hands of the mother has a bigger effect on family health than unearned income in the hands of the father. Notably, the effect on child survival probabilities is almost twenty times bigger.

Although there is considerable evidence against the unitary model, there seems to be no general agreement as to which non-unitary model should serve as the alternative. Several attempts have been made at testing the assumption of efficiency inherent in the collective model. Bourguignon et al. (1993) and Browning and Chiappori (1998) are not able to reject efficiency when examining household expenditure data from France and Canada respectively. Udry (1996) on the other hand, finds evidence against efficient allocation of resources within agricultural households in Burkina Faso. He finds that plots controlled by women have significantly lower yields than similar plots within the household controlled by men. Udry attributes the yield difference to higher labour and fertilizer inputs per acre on plots controlled by men, and estimates that six per cent of output is lost due to the misallocation. Lemay-Boucher and Dagnelie (2007) also reject efficiency when they use data from Benin to estimate a non-cooperative model of household behaviour. They conclude that spouses' financial spheres are relatively disconnected.[15] Doss and McPeak (2005) present several other findings of similar character in other African countries.

What is lacking in the literature, however, are tests between the collective model and alternative non-unitary models for high income countries (Browning et al 2011 p. 229). One notable exception is Browning and Lechene (2001) who reject the unitary model for Canadian households and find results consistent with the collective model with (to some extent) deferential preferences. They also find no signs of Warr-regions, a finding which is inconsistent with respect to the non-cooperative model and the standard Nash-bargaining model with a non-cooperative inside breakdown point (as in 3.2.5).

[15] LeMay-Boucher and Dagnelie (2007) note that non-cooperative behaviour between spouses is in accordance with several anthropological accounts on West-Africa.

4 Empirical Strategy

4.1 Data set

4.1.1 The US Consumer Expenditure Survey

To investigate the link between income distribution and household spending, I have chosen a data set from the US Consumer Expenditure Survey 2010. The survey is one of the most extensive of its kind and has been running in its current form since 1980. It is an ongoing survey where consumer units (CUs) are rotated on a quarterly basis; each quarter a portion of the CUs (roughly 1500) leave the survey and another set of CUs enter. Each CU can remain in the survey for up to five quarters.

> *A consumer unit consists of any of the following: (1) All members of a particular household who are related by blood, marriage, adoption, or other legal arrangements; (2) a person living alone or sharing a household with others or living as a roomer in a private home or lodging house or in permanent living quarters in a hotel or motel, but who is financially independent; or (3) two or more persons living together who use their incomes to make joint expenditure decisions. Financial independence is determined by spending behavior with regard to the three major expense categories: Housing, food, and other living expenses. To be considered financially independent, the respondent must provide at least two of the three major expenditure categories, either entirely or in part.*
>
> Bureau of Labor Statistics (2012)

The main reason for choosing this particular survey is that it collects information from all categories relevant for this thesis, namely household characteristics, income distribution and budget allocation. Each year the Bureau of Labor Statistics makes microdata sets from recently published reports available for public use. The microdata sets for 2010 were made available on September 27th 2011 and contain data from the first quarter 2010 to the first quarter of 2011 – five quarters in total.

The Consumer Expenditure Survey (CEX) consists of two components: An interview survey and a diary survey, each with a separate questionnaire and sample. In the former, each CU is interviewed on a quarterly basis about expenditures respondents are expected to be able to recall over a period of three months and longer. In the latter, each CU is asked to keep a

detailed diary of expenses over a period of two weeks. This is specifically designed to obtain detailed information about expenditures on frequently purchased items such as groceries.

Both components have their strengths and weaknesses as far as research purposes are concerned. The interview survey has the advantage that it covers a longer period of time so that is less sensitive to infrequency bias. It may however suffer from recall bias in the sense that although respondents are expected to recall their expenditures, they may not actually do so very accurately. As an example, of 445 observations of couples with at least one child under the age of two and where both spouses contributed to household income, roughly half of them recorded no spending on children's clothing the last quarter. That *may* accurately reflect the sample's spending habits, but it may also be a result of recall bias.

The diary survey is less prone to recall bias but is much more sensitive to infrequency bias which means that a household's expenditures over a period of two weeks may not accurately reflect household spending on infrequently purchased items over time. Since I am interested in items that are not necessarily bought on a weekly basis, the natural choice is the interview survey.

4.1.2 Sample selection

Seeing as children's clothing is a typical example of a household public good, I take couples with children as a starting point. To mitigate endogeneity issues related to relative income and time decisions (see section 4.1.4), only couples where both spouses were registered as working full time were kept in the sample. To reduce the possibility of more than two main decision makers being present in the household, I decided to keep only households where the oldest child was fifteen years old or younger. This also lines up neatly with recorded spending categories on clothing where a cut-off is at fifteen years of age. In order to construct the relative income variable I kept only households where both spouses contribute to household income and where there are in fact non-zero individual income records for both spouses.[16] In addition, I excluded households where at least one of the members has top-coded income because that would distort relative income calculations. 10 observations were removed due to very high budget shares for one or more goods. This left me with a sample of 812 quarterly

[16] Some households report that both spouses contribute to household income while one of the spouses reports no income in the individual records. This may happen because not all sources of household income are attributed to a household member.

observations spread out over five quarters. In the sample, the same CU may appear one, two, three or four quarters, but with individual expenditure records for each quarter. This obviously means that some households will be given more weight in the estimation process, but as long as the distribution of preferences does not vary systematically between the households that leave and households that enter the survey each quarter, that should not be a problem. I did briefly consider keeping only households for which I had four observations and then aggregate their spending records to construct yearly observations. The problem with this approach was that it would leave just above one hundred households – which I thought would be too few.

4.1.3 Choice of goods

In the CEX, each expenditure and income record is given a place within a system of Universal Classification Codes, informally known as UCCs. The UCCs are six digit codes that represent an item or groups of items. In the CEX 2010 a total of 751 UCCs are used. The BLS uses an aggregation scheme to construct broad expenditure and income categories, but users of the microdata sets are of course free to construct their own variables.

What constitutes a household public good is to some degree a matter for discussion. Very few goods are strictly public in the sense that they are completely non-rival and non-excludable. A TV for instance is public in the sense that one person watching a program does not preclude others from watching it, but it is private in the sense that the person holding the remote control effectively excludes other programs that *could* be watched. For testing the different models, I chose the following goods to form the dependent variables:

Children's clothing – Clothes and footwear for children up to 15 years of age. This is a "classic" household public good in the literature.

Household operations – This includes cleaning and gardening services, internet and computer services, babysitting and childcare. For a discussion of the inclusion of the services related to children, see the results chapter.

Household equipment – Small and major appliances, textiles and furniture and other equipment bought by the household.

Health insurance – It could be argued that this is not strictly a public good since it is often bought at an individual level. But it does include children's health insurance which arguably is a public good the same way children's clothing is. Furthermore, seeing as the family intrinsically contains an element of insurance for its members, health insurance for one member will to a certain extent benefit all members.

For a complete mapping of UCC codes to the dependent variables, see appendix B.

4.1.4 Is individual income an exogenous variable?

In the literature, considerable concern has been raised regarding the use of income, or relative income, as an independent variable and distribution factor (Ermisch 2003 p. 45; Browning et al 2011 p. 226; Rode 2011). The problems are related to which type of income that should be considered and their respective endogeneity issues. Monthly or yearly salaries are related to present time allocation decisions which in turn are – if we are to put our trust in economic theory – functions of prices and other sources of income. It has been suggested that total income should form the basis for calculating relative income (Ermisch 2003 p. 46), but it too is a function of time decisions, particularly past saving and investment behaviour. In theory, potential income could mitigate some of the problems because it reflects what a family member can threaten to do. But in addition to being correlated with past investments in human capital, it would require data that are not readily available.

Addressing the endogeneity problem in a satisfactory manner is a difficult task that lies beyond the scope of this thesis. However, in the sample I have kept only households where both spouses are registered as being in full time employment. In addition, I have included weekly hours worked by the husband and the wife respectively in the control variables. That might help reduce the problem, though clearly without solving it.

4.1.5 Summary statistics

This section contains summary statistics on budget shares and control variables. In addition I pay particular attention to the wife's relative income, which I denote by ρ (rho). Starting with the latter, Figure 9 shows the distribution of ρ in intervals of 0.025. Seeing as I have only included households were both spouses are in full time employment, the distribution of the wife's relative income is relatively centred around its mean of 0.45. It is also evident from Figure 9 that there are very few observations near $\rho = 0$ and $\rho = 1$. Estimates of the impact of the wife's relative income near either end of the spectrum will therefore be limited in precision.

As discussed in section 4.1.4, there are endogeneity issues associated with ρ and prices in the labour market because they may affect couples' time decisions. It is noteworthy, though, that the correlation between ρ and total expenditures (that will be used for calculating budget shares) is very low (-0.05). That suggests that households where the wife receives a larger share of reported income are on average neither richer nor poorer than other households.

Figure 10: The distribution of ρ

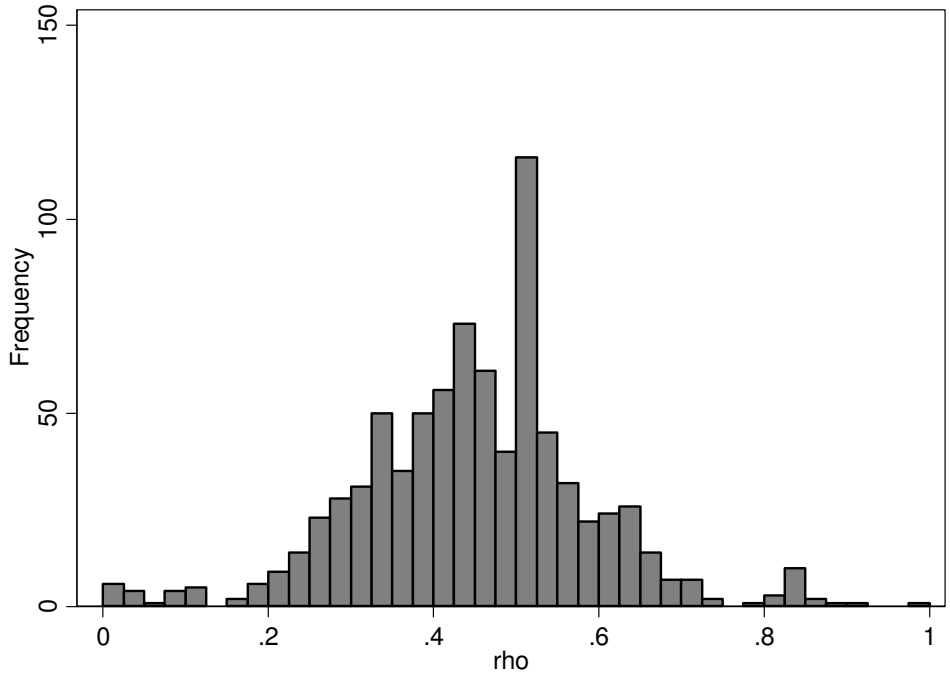


Table 1: Summary of demographic and other control variables

Variable	Mean	Std. dev.	Min	Max
Husband age	38.8	7.4	23	64
Wife age	36.7	6.7	22	55
Children < 2 years	0.22	0.43	0	2
Children 2 to 15 years	1.50	0.83	0	4
Children total*	1.72	0.73	1	4
Weekly hours husband	45.3	8.9	35	95
Weekly hours wife	41.6	5.7	35	84
	Husband		**Wife**	
	Frequency	**Per cent**	**Frequency**	**Per cent**
Race White	647	79.7	655	80.7
Race Black	86	10.6	70	8.6
Race Asian	72	8.9	66	8.1
Race Other	7	0.9	21	2.6
No education beyond high school	387	47.7	317	39.0
Some education beyond high school	425	52.3	495	61.0
Master's degree and beyond	111	13.7	158	19.5
		Frequency		**Per cent**
House owner		658		81.0
Region Northeast		142		17.5
Region Midwest		197		24.3
Region West		185		22.8
Region South		288		35.5
Metropolitan residence		730		89.9

* For reference only (not included in the estimations)

Table 1 shows an overview of control variables that can reasonably be thought to affect preferences. We see that the sample is predominantly white (80%), and that the average age is 39 for husbands and 37 for wives. Couples have on average just under two children, and no couple has more than four. Husbands work on average almost four hours more per week than wives do, while wives are on average better educated.

The Bureau of Labor Surveys record even more detailed information in categories such as education and homeowner status, but given the relatively small sample size I have combined several finer categories into broader ones so as to reduce the chance of noise affecting estimates.

Table 2: Budget share and income variables

Variable	Mean	Std. dev.	Min	Max
Children's clothing	0.009	0.010	0	0.058
Household operations	0.052	0.067	0	0.037
Health insurance	0.035	0.040	0	0.337
Household Equipment	0.021	0.038	0	0.306
Wife's income	48467	27141	1	245000
Husband's income	60888	35579	60	275000
Total expenditures	17904	8712	4535	85169

Table 2 presents summary statistics for the budget shares relating to the household public goods and the income variables used for calculating ρ. Notably, husbands make on average roughly 12000 dollars a year more than wives do. As can also be seen from Table 2, the data is quite noisy with respect to budget shares. This may be due to infrequency bias, recall bias or both. For every expenditure category except household operations, the number of zero-observations is in excess of 200. For household operations the number of zero-observations is 65. Whether the zero-observations reflect spending behaviour or poor memory is hard to tell. Although the Bureau of Labor Surveys distinguishes between complete and incomplete income reporters, there is no equivalent classification with respect to expenditures. Dropping households that reported zero spending in one or more categories would reduce the sample to 332 households which would constitute a very small sample. In addition, it might have removed a considerable amount of true zero-observations as well, and thereby traded one kind

of bias for another. I therefore decided to keep households with zero budget shares for one or more expenditure categories.

4.2 Estimations

4.2.1 The model

In the theory section I presented three classes of non-unitary models and different variants of them depending on the structure of preferences. Each variant predicts a different spending pattern as a function of the wife's share of income (see Figure 9, section 3.4). In linear terms, the models predict different combinations of flat segments and sloped segments. The true demand functions need of course not be linear, but it seems like a reasonable approximation for testing between alternative models. It also allows for using continuous piecewise linear regression as a starting point, a procedure that is readily available in modern statistical software.[17] The general model is as follows:

$$S_i = \alpha_i + f^i(\rho) + \sum_{j=1}^{n} \beta_{ij} X_{ij} + \varepsilon_i \qquad (4.1)$$

S_i is the budget share for good i. f is a function describing the relationship between the wife's share of income, ρ, and the budget share for good i. The next term is the set of explanatory variables other than ρ. This includes spouses' age, demographic variables, the log of total expenditures and its square.

4.2.2 Estimation procedure

The main questions regarding the estimates are: Does ρ have a significant impact? Are there any kink points with respect to ρ? How many kink points are there? And *where* are they?

There are probably many ways one could go about to answer these questions, particularly when it comes to searching for kink points. Rather than searching for kink points manually, I decided to adopt a procedure partly based on what is commonly known as a *brute-force search*. In essence, the procedure involves testing all possible combinations of inputs until

[17] Estimations were carried out using STATA 11.

one finds the optimal result. In the context of my estimations, the procedure can be briefly described as follows:

1) Divide the observations of ρ into a theoretical set of intervals with lengths 0.025. Let the join points be the potential kink points.

2) Impose the restrictions associated with the predicted spending pattern from a variant of a particular model (e.g. "flat-slope" or "slope-flat-slope") in the *f*-function.

3) Estimate the model using OLS with robust variance estimators for all possible combinations (if any) of potential kink points.

4) Select the combination of kink points (if any) that yields the highest R^2.

5) Repeat the steps for each possible combination of flat and sloped segments.

6) Test the variants against each other for statistical significance using a combination of F-tests, J-tests and CPD-tests (see section 4.2.3).

Steps 1) to 5) was carried out using an algorithm written for Stata 11. Step 6) was for the most part done manually based on the results from the previous steps. The reason for this is that initial results would indicate which models (if any) seemed like good candidates, and testing all model variants against each other seemed impractical and redundant. When pitting the model variants against one another, I let the fact that adding kink points by itself often will produce a better fit have implications in the following sense; the null hypothesis would be that the model with fewer kink points was the best fit. This was also important for the interpretation of the results.

4.2.3 The J-test and the CPD-test

Both the J-test and the CPD-test are designed to compare the possible truth of two non-nested models that have the same response variable but differ in their regressor lists (Baum 2006 p. 100; MacKinnon 2006 p. 1). That the models are non-nested means that you cannot impose one or more restrictions on one of the models in order to get the second model (otherwise a Wald-test could be used). The method of the J-test (aka Davidson-MacKinnon-test) can be described as follows (Baum 2006 p. 100). Consider two competing models, (1) and (2), that have the same dependent variable but different independent variables. The J-test runs both

regressions and predicts the fitted values. It then treats the fitted values from model (1) as an independent variable in an augmented regression of model (2) and vice versa for model (1). The estimated coefficients on the fitted values are then tested for significance using a standard t-test. The logic is that if the fitted values of model (1) have significant explanatory power in model (2), this is interpreted in favour of model (1) being the superior model – and vice versa. This means that it is possible that one model is rejected in favour of the other, that both are rejected or that neither is rejected, in which case the test is considered inconclusive.

The CPD-test (aka Cox-Pesaran-Deaton-test) is more complicated, but the general idea is that one can test the validity of model (1) by comparing the observed value of the log-likelihood function for model (2) with an estimate of what the latter should be if model (1) is true (Davidson and MacKinnon 1985 p. 46). Both the J-test and the CPD-test can be implemented in Stata using the nnest-package.

4.2.4 Restrictions regarding possible kink points

In addition to the restrictions associated with the combinations of flat and sloped segments, several other restrictions were imposed. I restricted the kink points to be in the interval [0.2, 0.8]. There are several reasons for this. First, the observations of ρ is such that estimating kink points near the ends of the spectrum is difficult since there are relatively few observations in those intervals. Second, any arbitrary concentration of a few high or low observations near the ends of the spectrum might give rise to local kink points that could distort the overall results. It could also be added that any kink points near the end points are likely to be caused by Becker-regions, and it seems reasonable to expect them, if present, to extend to at least the neighbourhood of ρ =0.02 or ρ=0.8. Furthermore, I restricted the kink points to be at least 0.075 apart. This means for instance that any estimated Warr-region will be at least 0.075 "long" in terms of ρ, which seems reasonable. It also means assuming that if the wife's share of income is indeed a distribution factor in the collective model (or in the Nash model) for a sub-interval of [0 , 1], that sub-interval is at least 0.075 long. The restriction also contributes to setting the different model variants apart from one another. After all, the point of the exercise is to investigate whether one type of model fits the data significantly better than do others, and that would be hard to do if models are very similar. If I had allowed kink points to "stack up", clusters of observations could produce results across models that were hard to interpret. Consider the following example: If the true model is the collective model with

Becker-regions (flat-slope-flat) and kink points 0.025 apart, then identifying it using the data at hand is next to impossible given that one would always wonder whether the estimated results came from the data or the true model. But if the aforementioned model is the one producing the data, it would still be reasonable to expect that an estimated collective model with kink points 0.075 apart would fit the data better than, say, a model with only a slope.

All the restrictions discussed were incorporated in the algorithm that estimated the different model variants according to the following table (see also Figure 9, section 3.4).

Table 3: Overview of the different model variants estimated

Shape	**Kink points**	**Corresponding model(s)**	**Number of combinations**
(flat)	-	Control variables only (unitary)	1
slope	-	Collective, both egotistic	1
flat-slope	1	Collective, husband deferential	21
slope-flat	1	Collective model, wife deferential	21
flat-slope-flat	2	Collective model, both deferential	253
slope-flat-slope	2	Non-cooperative and Nash-bargaining, both egotistic	253
flat-slope-flat-slope	3	Non-cooperative and Nash-bargaining, husband deferential	1330
slope-flat-slope-flat	3	Non-cooperative and Nash-bargaining, wife deferential	1330
slope-flat-slope-flat-slope	4	Non-cooperative and Nash-bargaining, both deferential	3876
		SUM REGRESSIONS	**7086**

Note that even though the non-cooperative models and the Nash-bargaining models fall in the same general shape categories, they differ with respect to the signs on the slopes. For instance, the basic non-cooperative model is "negative-flat-positive" whereas the Nash-bargaining model is either "positive-flat-positive" or "negative-flat-negative" (depending on which spouse has the strongest preference for the good). This means that as the "best" slope-flat-slope model is selected, one variant will implicitly be rejected given the estimated signs on the slope coefficients. The same goes for the other "pairs" of models.

As a cross-check, I also estimated a model for each good using control variables only, i.e. dropping $f(\rho)$ from the right hand side of (4.1). I then computed the fitted values and the corresponding residuals from this model before doing a (non-parametric) second order local polynomial regression with local-mean smoothing[18] on the residuals using ρ as the independent variable. The logic is that once the control variables are accounted for, the impact of ρ can be approximately traced out using this method. It can therefore be used to cross-check the shape and the location of the estimated kink points (if any) of the preferred linear model. Plots of these auxiliary regressions are included in chapter 5.

[18] In Stata, this corresponds to using the lpoly-command with the epanechnikov-kernel and standard options.

5 Results

5.1 Overview

This chapter presents results from the estimations and a discussion of possible interpretations. Separate regressions were run for each household public good to allow for decision processes and/or preferences to differ across goods. Results are presented for one good at a time along with plots of the preferred linear models and the local polynomial regressions. The plots serve to illustrate the estimated impact on demand for the different public goods of the intra-household income distribution. The discussion follows after the presentation of the results themselves. Detailed estimation results for the preferred linear models can be found in Appendix A.

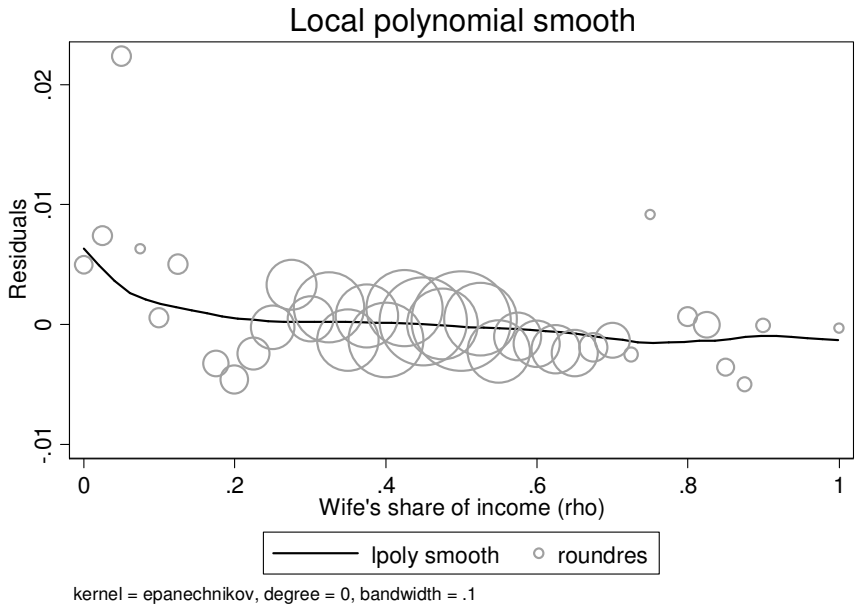
For three of the four household public goods, the estimations returned statistically significant results with respect to the wife's share of income, ρ. These are children's clothing, household operations and health insurance. For household equipment, the wife's share of income does not have a statistically significant impact. The tests between the alternative linear models returned results that were indicative, but not entirely conclusive. Given the limited number of observations at relatively high or low values of ρ, some of the results rely on few observations and are hard to interpret. The fact that certain sloped segments in a model are statistically significant does not in itself justify economic interpretation. Deciding which of the linear models had the best fit thus turned out to be less than straightforward. May 13th

5.2 Children's clothing

For the household's budget share on children's clothing, ρ seems to have an effect, but tests on which of the non-unitary models that fit the best are not conclusive. The local polynomial regression suggests a downward sloping trend with at least one possible kink point around ρ=0.2.

The collective model with egotistic preferences (slope-only) has a slope coefficient that is significant at the 1% level (Figure 12, top panel). The preferred model with kink points is the Nash bargaining model where the wife has deferential preferences (Figure 12, bottom panel), and the slope-only model is rejected at the 1% level against this model using both a J-test and a CPD-test. But the results seem to rely on the relatively few observations of ρ<0.2 (28 observations). There are no extreme values in this interval; it is just that the average budget share in this interval is relatively higher. Whether this is coincidental or not is impossible to

Figure 11: Children's clothing, local polynomial regression

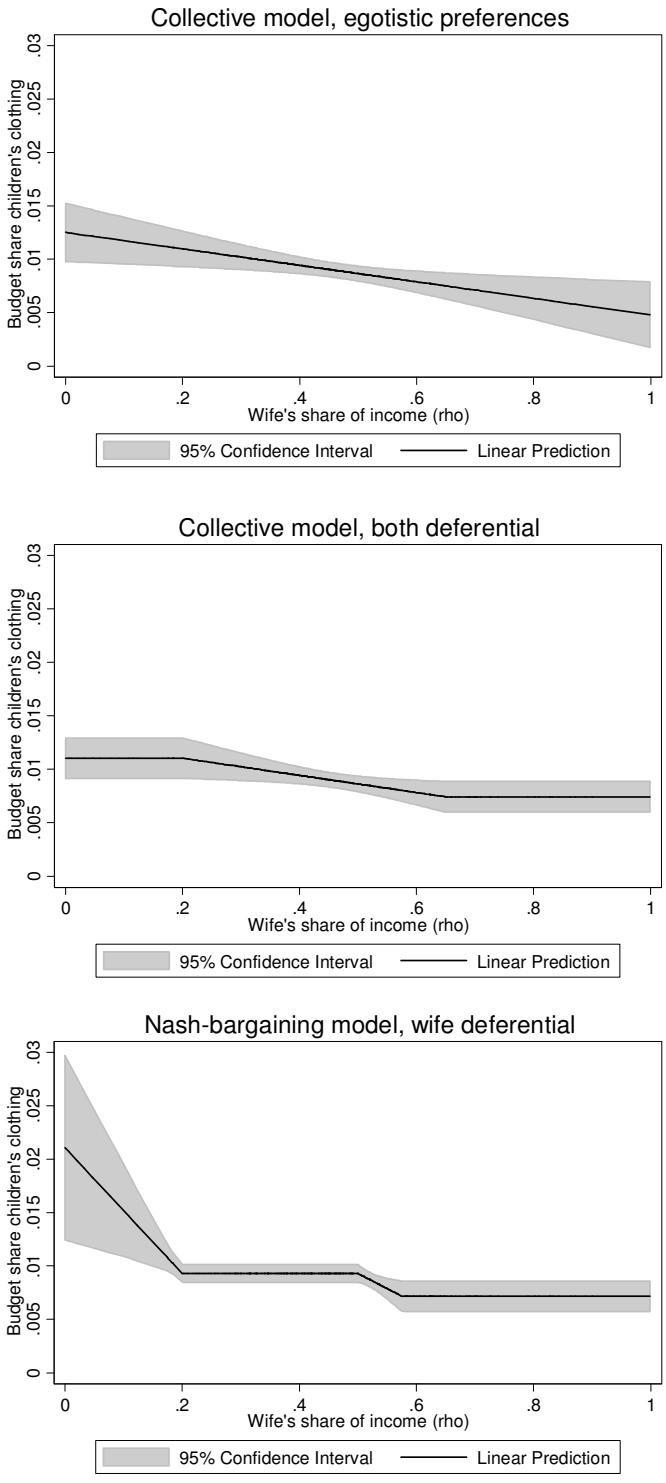


Explanation of the above plot: The line is a second order local polynomial regression using local-mean smoothing on the residuals from the model with control variables only. The circles represent the average residual from the observations of rho rounded to the nearest 0.025. The size of each circle is proportional to the number of observations for each point.

tell. I ran the estimation algorithm on a sample where I dropped the observations for ρ<0.2. In that case, the Nash model no longer was the preferred model – the collective model with deferential preferences was (Figure 12, middle panel). Incidentally, if the coefficient on the leftmost slope of the preferred Nash-model is restricted to zero, that model effectively becomes a collective model with deferential preferences. This shows how the Nash bargaining model being the statistically preferred model relies on those few observations for low values of ρ.

It is therefore difficult to conclude which of the linear models that shows the best fit. I do, however, interpret the overall results as evidence against the unitary model.

Figure 12: Children's clothing, linear models



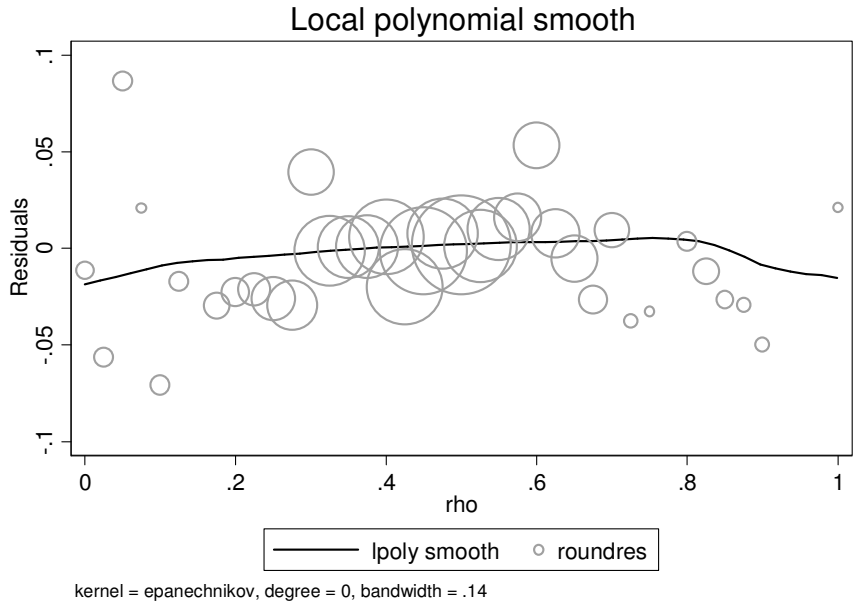
Explanation of the above plots: The solid lines are the predicted values from the model when the control variables are set to their respective means. The 95% confidence intervals are generated using the robust variance estimates for the slope coefficients for each linear segment.

5.3 Household operations

Household operations is a service-oriented expenditure category that includes cleaning and gardening services, internet and computer services, babysitting and childcare. The estimated impact of ρ is significant, but this has a lot to do with services relating to children.

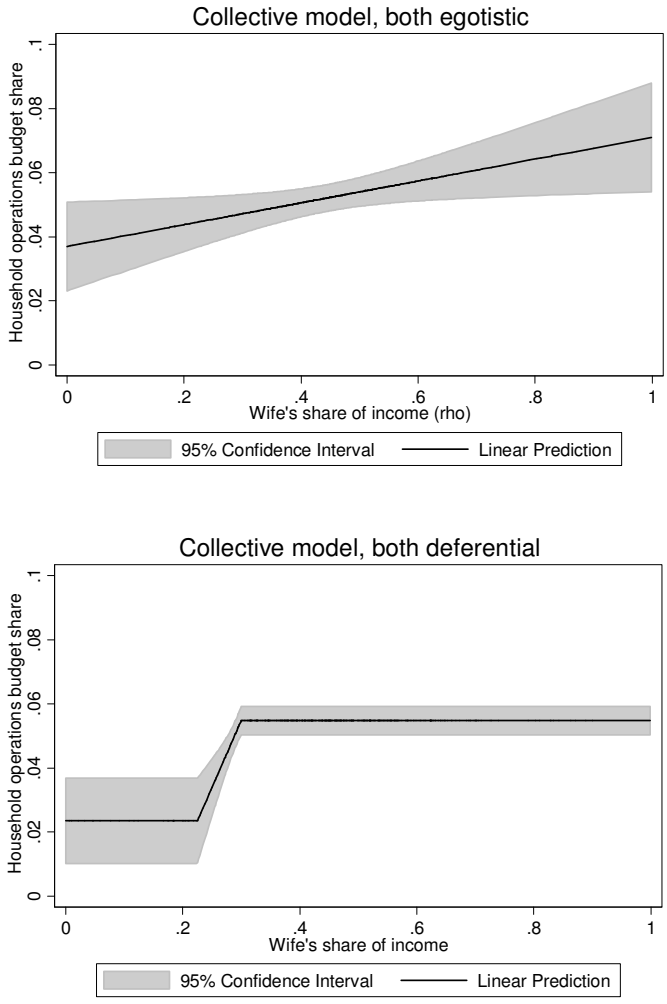
The local polynomial regression yields a rather strange "inverted" shape that is inconsistent with theory. This may very well be because of the few observations near the end points being coincidentally low, so it's hard to interpret the "dips" result as evidence against anything. In the interval [0.2 , 0.8] where most of the observations are, there is a positive trend and the estimated collective model with egotistic preferences (slope-only) has a significant slope coefficient of 0.034 (p-value is 0.025). In other words; the low values near the end points do not cancel out the positive trend in the middle segment. Of the models with kink points, the preferred model is the collective model where both spouses have deferential preferences. The slope-only collective model is rejected against this variant using both a J-test and a CPD-test. But there is no sign of the rather steep slope in the lpoly-estimation, which I think is a sign that the results from the J-test and the CPD-test should be interpreted with caution. As for the

Figure 13: Household operations, local polynomial regression



other model variants, three of them[19] showed the same inverted shape as the lpoly-plot, which means that the estimated signs on one or more slope coefficients were inconsistent with theory. This may simply be a result of overfitting near the end points, but is nevertheless not supportive of the corresponding models. The collective model with flat segments was not rejected against any of the "strange" variants, but in two instances the results were inconclusive in the sense that the competing model was not decisively rejected either.

Figure 14: Household operations, linear models



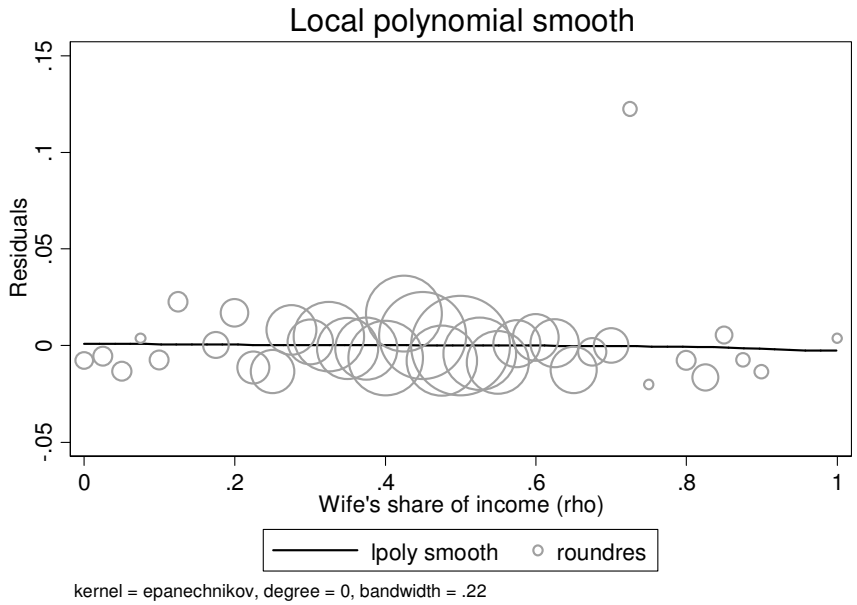
It should be noted, however, that the positive slope depends on babysitting and child care being present in the aggregate dependent variable. Remove the childcare categories from "household operations" and the basic collective model will not cause the unitary model to be rejected. The collective model with flat segments will, however, but with the opposite sign on the slope. This illustrates how much of an impact child services has for the results.

[19] The models were slope-flat slope and the two variants with three kink points. The model with four kink points had consistent signs (positive-positive), but was rejected against the preferred collective variant.

5.4 Household Equipment

Household equipment includes small and major appliances, furniture, textiles and other miscellaneous equipment. For this expenditure category, the estimated effects of the wife's share of income are next to none.

Figure 15: Household equipment, local polynomial regression

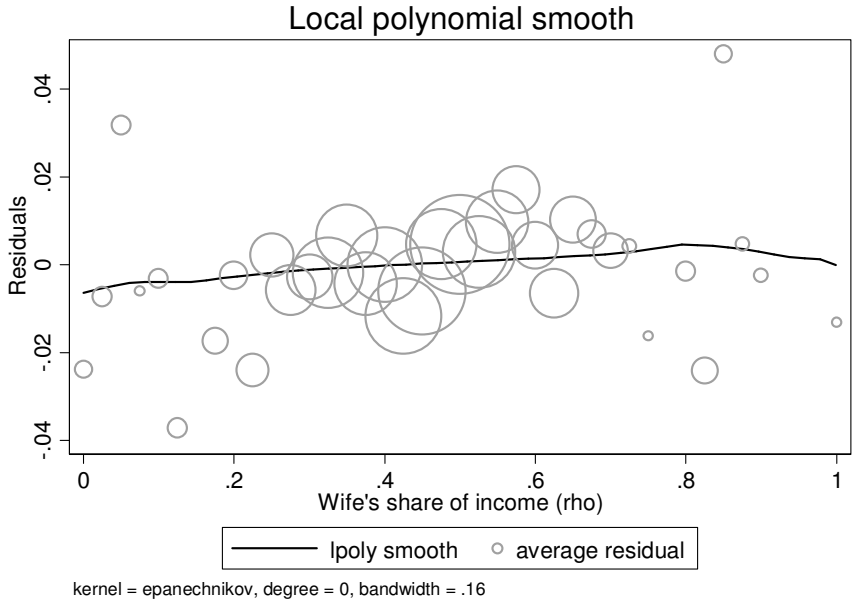


The above plot indicates no impact of ρ on the demand for household equipment. This was confirmed by the slope-only model estimate that had an insignificant slope coefficient (p=0.422). As for the model with kink points, the algorithm returned model estimates where some had slope signs inconsistent with theory in addition to most of the coefficients being insignificant. In addition, the J-tests and the C-P tests were inconclusive in the sense that none of the kink-point models were strictly preferred over the others. This is evidence against ρ having a significant impact in this expenditure category.

5.5 Health insurance

As briefly discussed in section 4.1.3, health insurance is both private and public in nature. Plans are available for individuals as well as families, but the fact that health insurance for one individual to an extent benefits all family members means that even the individual plans have properties consistent with being public goods. Health insurance for children is arguably a public good to the parents. A possible problem with the reported data in this category is that a number of households might have plans paid for by their employer, and may or may not interpret these as expenditures. Nevertheless, the estimations suggest that when the wife receives a larger share of household income, more is spent on health insurance.

Figure 16: Health Insurance, local polynomial regression

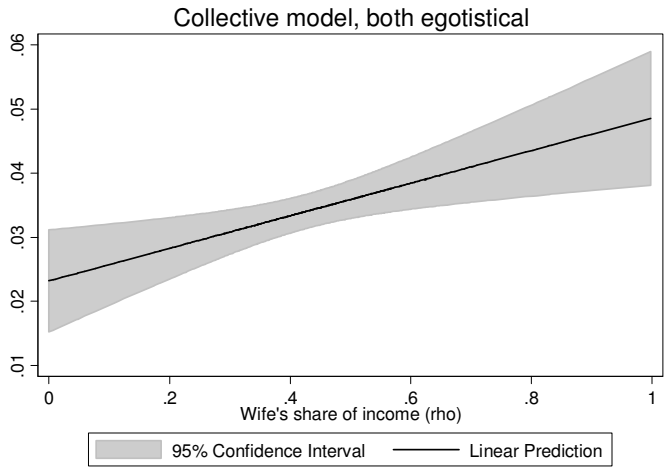


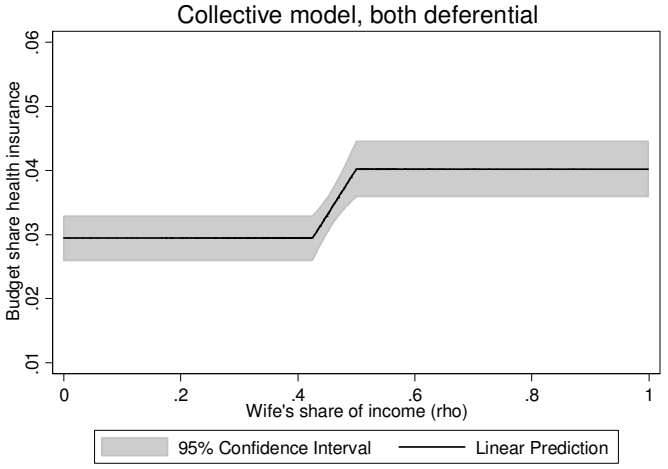
The local polynomial regression is similar in shape to that for household-operations in the sense that it has a positive trend in the middle but a "dip" for high values of ρ. This "dip" is inconsistent with theory, but is driven by the sparse observations at the upper end of the scale. The preferred linear model is the collective model with deferential preferences, but the kink points are not indicated by the lpoly-plot. The kink points are also as close together as the algorithm permits, which may be a sign of local overfitting. None of the models with more

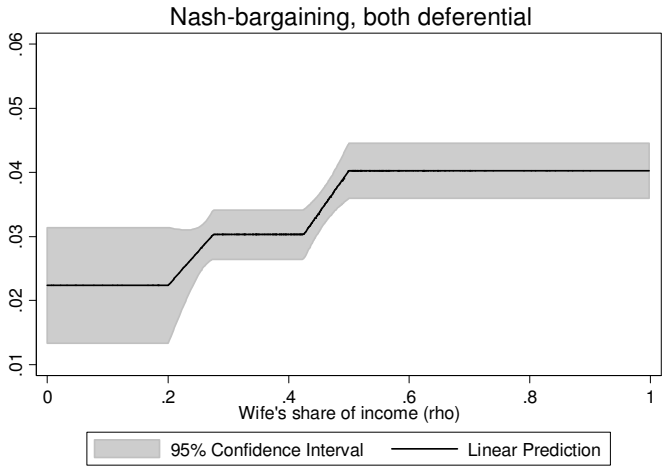
kink points gave an improvement over this model. Notably, the Nash model with four kink points, the flat-slope-flat model with an additional flat Warr-region in the middle, was rejected against the model with only two kink points using a J-test (the CPD-test was inconclusive). But the slope only-model was rejected against the four-point model, so being cautious about the slope-flat-slope model means that one cannot rule out the Nash-model completely.

The slope coefficient in the slope-only model is significant at the 1% level, so the unitary model is rejected on that basis alone. The estimate suggests that for every 10 per cent of household income that the wife controls, the budget share on health insurance increases 0.25 percentage points. In the corresponding model with deferential preferences, the budget share increases roughly one percentage point from ρ=0.425 to ρ=0.5. In total, this indicates that households where the wife receives relatively more income spend more on health insurance, but given the uncertainties about the models, the effect is hard to quantify.

Figure 17: Health Insurance, linear models







5.6 Summary of results

Overall, the results points towards a rejection of the unitary model and the income pooling hypothesis. The wife's share of household income has a statistically significant impact for three of the four goods. Of the three alternative models, the collective model is the one that most consistently stands out as a preferred alternative. Some of the results indicate deferential preferences, but it is hard to make any definite conclusions. This is partly due to the lack of observations for high or low values of ρ, and partly because of the rather small sample size. The latter is important because the smaller the sample size, the more estimates of kink points may be vulnerable to local clusters of high or low budget shares. That means that deferential preferences may be statistically preferred more because of local overfitting than anything else.

It is interesting to note that the non-cooperative model is virtually absent from the linear estimates. In other words; I find no signs of a flat Warr-region surrounded by upward sloping segments for any of the goods. The estimation procedure "forces" a slope-flat-slope model to be estimated for each good in order for it to be tested against other variants, but the returned estimates were either a Nash model (see Figure 9, section 3.4) or inconsistent with theory.

None of the more complicated models with three kink points or more gave an improvement, except for in the children's clothing category. But seeing as that particular result relies on a very small number of observations for low values of ρ, I am cautious about its significance. The Nash model was not a preferred model for any other goods. It should be noted, however, that in testing the models against one another, the null hypothesis was always that it was the model with fewer kink points that was the preferred model. If it really is a Nash model with deferential preferences that is generating the data, the sample size may be too small and/or the noise too great for the Nash model to stand out statistically.

As for the non-result in the household equipment-category, there may be several reasons why the wife's share of income does not play a part. One possibility is that the unitary model is the correct model for this category of household expenditure. Another might be that private preferences on average cancel out because household equipment is a very broad expenditure category. For instance, let's say that traditional gender stereotypes are relevant in this context, and that men on average prefer upgrading the household's power tools and lawn mower to upgrading the food processor and the curtains – and that for women it is the other way

around.[20] It is then possible that the spouse with the largest share of household income is able to push the budget in the direction he or she wants, but that the overall equipment budget does not change. Testing for such an effect, however, would mean assigning the 71 UCC-codes that make up "household equipment" to a specific gender, which seems overly conjectural. It could also be that private preferences cancel out in a way not associated with gender stereotypes. A third possibility is that because household equipment includes durables such as stoves and sofas,[21] the infrequency bias might generate so much noise in the data that any effects from differences in bargaining power would be effectively undetectable in the snapshot of a cross-section.

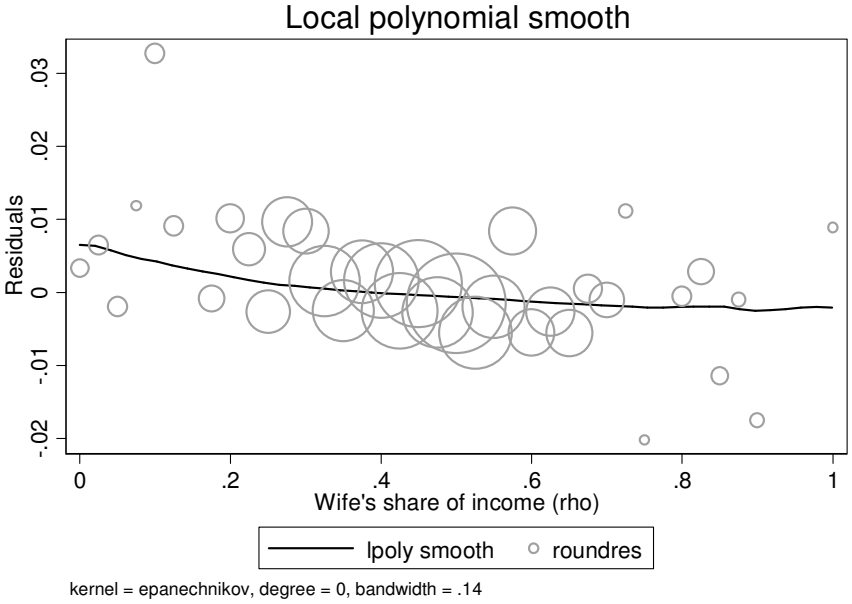
As for the three goods where the estimated impact of the wife's share of income was significant, one result in particular is a bit puzzling, namely that for the budget share for children's clothing. The reason is that the estimated effect is the opposite of what is found in other studies (Lundberg et al 1997; Browning and Lechene 2001). According to my estimates of the collective model, when the wife's share of income is 10 percentage points higher, the budget share on children's clothing is on average *reduced* by 0.08 percentage points. That is not much, of course, but it is still a bit surprising. It would seem that within the sample, the men have on average a stronger preference for children's clothing than do women. It is also worth mentioning that all model variants returned signs on the sloped segments that were consistent with this, even those models that were rejected against other models.

[20] See section 5.7 for an experiment with this line of thought.
[21] I did experiment with removing all «big items» from the dependent variable, but it rendered the budget shares too small to do any meaningful estimations.

5.7 Bonus track: TV, radio and sound equipment

This category is not among the goods listed in section 4.1.3, because ex ante it is hard to characterize it as either a public good or a private good. It is public in the sense that someone turning on the stereo does not preclude anyone from listening to the same music. But it becomes private if that person puts on a set of headphones. Following my own gender stereotypes in the household equipment-category (section 5.46), I thought it would be interesting to see if the budget shares were consistent with the casual observation that men have a stronger preference for big screen TV's and expensive hifi-equipment. It turns out that the data lend support to this claim.

Figure 18: TV, radio and sound equipment, local polynomial regression

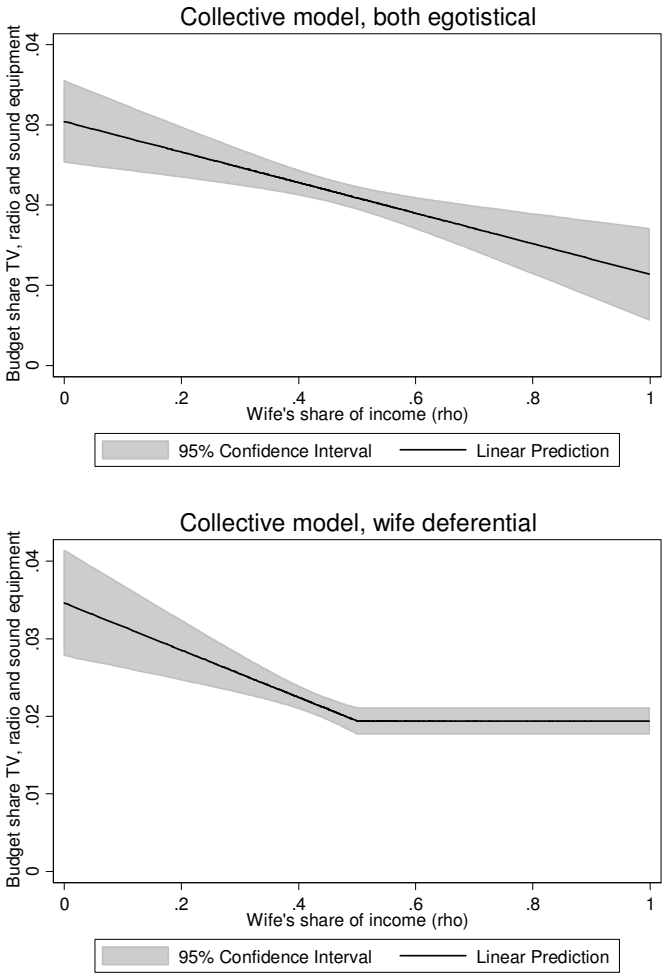


The local polynomial regression shows clear signs that the budget share decreases as the wife controls more of household income. It also suggests that this effect is stronger for smaller shares of the wife's income. The slope-only model has a coefficient that is significant at the 0.1% level, but this is rejected against the slope-flat model with the kink point located at ρ=0.5. This corresponds to the collective model where the wife has deferential preferences. In other words; as the wife's share of income increases, the budget share for TV, radio and

sound equipment decreases down to the point where she controls half of household income. None of the models with more kink points gave a significant improvement over the slope-flat model.

It is interesting that none of the control variables produced significant coefficients. In the context of the collective model with deferential preferences, the budget share is reduced by 0.3 percentage points for every 10% of household income received by the wife (up to 50%). It would seem that big TVs and expensive sound equipment really are ”boys’ toys” after all.

Figure 19: TV, radio and sound equipment, linear models



6 Concluding Remarks

This thesis is about modelling family behaviour in an economic context. As the amount of evidence against the standard unitary model has grown, economists have searched for better ways of describing how families make use of scarce resources and what drives the decision process. In the theory section, I presented several alternatives to the unitary model of family behaviour. I demonstrated how different assumptions about the family decision process and family member's preferences lead to radically different predictions about how intra-household income distribution affects household demand.

In the empirical section, I presented a method for estimating the various model variants and testing which one best fits the data. I then applied this method to a sample of 812 married couples with children using data sets from the US Consumer Expenditure Survey 2010. After controlling for a range of demographic and other variables, I estimated the impact of the wife's share of household income on four expenditure categories that reasonably could be classified as household public goods.

Overall, the results were in line with previous rejections of the unitary model and the income pooling hypothesis. I have found several indications of the collective model being an appropriate replacement. Furthermore, the results suggest that deferential preferences could be an appropriate representation of the observed behaviour, but the number of couples with highly skewed income distribution were too limited to conclude one way or the other. Corresponding to the evidence in favour of the collective model, I found no evidence of the non-cooperative model being an active player in this field. The only signs I found of a Warr-region being present pointed towards the Nash-model, but these signs were few and ambiguous at best.

As previously discussed, the results are definitely not conclusive. The data set is quite noisy, the sample is rather small and the number of households reporting zero budget shares for major expenditure categories adds to the uncertainty. In addition, there are unresolved endogeneity issues associated with intra-family income distribution, which means treating the wife's share of income as an independent variable has its drawbacks. It should also be said that by using cross-sectional data, I have effectively ignored the time dimension in the analysis. Intertemporal models of family behaviour might be able to explain observed

behaviour better than any of the models I put to the test. If family members are forward-looking, not only current bargaining power but also the prospect of future bargaining power could affect decisions today.

It is also worth bearing in mind that several possible distribution factors other than relative income are unaccounted for in my analysis, simply because of lack of data. Possible distributions factors could be potential earnings, savings and capital income, marriage market attributes, divorce laws and social customs. These distribution factors may or may not be correlated with relative income, and could have altered the picture if they were present in the data.

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Appendix A: Detailed results

Children's clothing
Collective model, egotistic preferences

	Coefficient	Robust SE	t-stat	p-value
rho	-0,0077159	0,0028695	-2,69	0,007
ln (Total Expenditures)	0,0355225	0,0220574	1,61	0,108
[ln (Total Expenditures)]^2	-0,0019458	0,001113	-1,75	0,081
Husband hours worked per week	0,0000291	0,0000399	0,73	0,466
Wife hours worked per week	0,0002316	0,000073	3,17	0,002
Husband age	-0,0000712	0,0000913	-0,78	0,436
Wife age	-0,0002309	0,000555	-0,42	0,677
Wife age^2	0,0000048	0,0000069	0,69	0,490
Husband education beyond high school	-0,0019993	0,0009119	-2,19	0,029
Husband master's degree and beyond	0,0001279	0,0012075	0,11	0,916
Wife education beyond high school	0,0004433	0,0009412	0,47	0,638
Wife master's degree and beyond	-0,0012429	0,0009443	-1,32	0,188
Children under 2 years	0,0065777	0,0011042	5,96	0,000
Children 2 to 15 years	0,0021907	0,0005739	3,82	0,000
Houseowner	0,0012493	0,0009906	1,26	0,208
Region Midwest	0,0011762	0,0011172	1,05	0,293
Region South	-0,0005643	0,0010141	-0,56	0,578
Region West	-0,0002562	0,0010174	-0,25	0,801
Metropolitan residence	-0,0025406	0,0015406	-1,65	0,100
Husband black	-0,0012013	0,0020785	-0,58	0,563
Wife black	0,0035072	0,0024173	1,45	0,147
Husband Asian	0,0032469	0,0018877	1,72	0,086
Wife Asian	-0,0028387	0,0018075	-1,57	0,117
Wife other	-0,000442	0,0024201	-0,18	0,855
Husband other	0,0065822	0,0050172	1,31	0,190
_cons	-0,1577653	0,1064866	-1,48	0,139
Number of obs.	812			
R2	0,1166			
F(25, 786)	3,81			
Prob > F	0,0000			

Children's clothing
Collective model, deferential preferences

	Coefficient	Robust SE	t-stat	p-value
rho: (0.2 , 0.65)	-0,0080350	0,0034359	-2,34	0,020
ln (Total Expenditures)	0,0346722	0,0220432	1,57	0,116
[ln (Total Expenditures)]^2	-0,0019043	0,0011119	-1,71	0,087
Husband hours worked per week	0,0000321	0,0000399	0,80	0,421
Wife hours worked per week	0,0002281	0,0000736	3,10	0,002
Husband age	-0,0000722	0,0000920	-0,79	0,433
Wife age	-0,0002398	0,0005555	-0,43	0,666
Wife age^2	0,0000049	0,0000069	0,70	0,482
Husband education beyond high school	-0,0019604	0,0009155	-2,14	0,033
Husband master's degree and beyond	0,0001753	0,0012043	0,15	0,884
Wife education beyond high school	0,0004294	0,0009414	0,46	0,648
Wife master's degree and beyond	-0,0012486	0,0009447	-1,32	0,187
Children under 2 years	0,0066210	0,0011076	5,98	0,000
Children 2 to 15 years	0,0022145	0,0005766	3,84	0,000
Houseowner	0,0012779	0,0009920	1,29	0,198
Region Midwest	0,0011229	0,0011172	1,01	0,315
Region South	-0,0005783	0,0010158	-0,57	0,569
Region West	-0,0002418	0,0010181	-0,24	0,812
Metropolitan residence	-0,0026209	0,0015515	-1,69	0,092
Husband black	-0,0012274	0,0020844	-0,59	0,556
Wife black	0,0034863	0,0024144	1,44	0,149
Husband Asian	0,0031568	0,0018835	1,68	0,094
Wife Asian	-0,0028239	0,0018076	-1,56	0,119
Wife other	-0,0003262	0,0024208	-0,13	0,893
Husband other	0,0062667	0,0050141	1,25	0,212
_cons	-0,1546437	0,1064464	-1,45	0,147

Number of obs.	812
R2	0,1144
F(26, 785)	3,76
Prob > F	0,0000

Children's clothing
Nash-bargaining model, egotistic preferences

	Coefficient	Robust SE	t-stat	p-value
rho: (0 , 0.2)	-0,058881	0,022230	-2,65	0,008
rho: (0.5 , 0.575)	-0,028518	0,011808	-2,42	0,016
ln (Total Expenditures)	0,041662	0,022543	1,85	0,065
[ln (Total Expenditures)]^2	-0,002252	0,001139	-1,98	0,048
Husband hours worked per week	0,000025	0,000041	0,61	0,539
Wife hours worked per week	0,000228	0,000071	3,22	0,001
Husband age	-0,000071	0,000092	-0,77	0,442
Wife age	-0,000202	0,000554	-0,36	0,715
Wife age^2	0,000004	0,000007	0,62	0,534
Husband education beyond high school	-0,002063	0,000902	-2,29	0,023
Husband master's degree and beyond	0,000364	0,001199	0,30	0,761
Wife education beyond high school	0,000493	0,000948	0,52	0,603
Wife master's degree and beyond	-0,001360	0,000915	-1,49	0,138
Children under 2 years	0,006266	0,001094	5,73	0,000
Children 2 to 15 years	0,002108	0,000568	3,71	0,000
Houseowner	0,001392	0,000993	1,40	0,161
Region Midwest	0,001402	0,001119	1,25	0,211
Region South	-0,000570	0,001012	-0,56	0,573
Region West	-0,000200	0,001018	-0,20	0,844
Metropolitan residence	-0,002262	0,001491	-1,52	0,130
Husband black	-0,000888	0,002068	-0,43	0,668
Wife black	0,003275	0,002425	1,35	0,177
Husband Asian	0,003150	0,001917	1,64	0,101
Wife Asian	-0,002941	0,001826	-1,61	0,108
Wife other	0,000078	0,002491	0,03	0,975
Husband other	0,006196	0,005115	1,21	0,226
_cons	-0,180205	0,108433	-1,66	0,097
Number of obs.	812			
R2	0,1290			
F(26, 785)	4,01			
Prob > F	0,0000			

Household Operations
Collective model, egotistic preferences

	Coefficient	Robust SE	t-stat	p-value
rho	0,034083	0,015152	2,25	0,025
ln (Total Expenditures)	0,272995	0,137604	1,98	0,048
[ln (Total Expenditures)]^2	-0,013349	0,007084	-1,88	0,060
Husband hours worked per week	-0,000228	0,000259	-0,88	0,378
Wife hours worked per week	-0,000046	0,000392	-0,12	0,906
Husband age	-0,001043	0,000508	-2,05	0,041
Wife age	0,001436	0,002980	0,48	0,630
Wife age^2	-0,000032	0,000036	-0,89	0,373
Husband education beyond high school	0,008025	0,005063	1,58	0,113
Husband master's degree and beyond	-0,001661	0,008604	-0,19	0,847
Wife education beyond high school	0,008903	0,004893	1,82	0,069
Wife master's degree and beyond	0,035453	0,007957	4,46	0,000
Children under 2 years	0,021310	0,007493	2,84	0,005
Children 2 to 15 years	0,005433	0,002921	1,86	0,063
Houseowner	0,007165	0,005479	1,31	0,191
Region Midwest	0,017277	0,007359	2,35	0,019
Region South	0,012813	0,006725	1,91	0,057
Region West	0,004782	0,006878	0,70	0,487
Metropolitan residence	0,006857	0,007514	0,91	0,362
Husband black	0,015296	0,012254	1,25	0,212
Wife black	-0,024232	0,013361	-1,81	0,070
Husband Asian	-0,003841	0,014935	-0,26	0,797
Wife Asian	-0,006120	0,014806	-0,41	0,679
Wife other	-0,011992	0,008329	-1,44	0,150
Husband other	0,013141	0,020048	0,66	0,512
_cons	-1,356899	0,671296	-2,02	0,044
Number of obs.	812			
R2	0,1955			
F(25, 786)	8,16			
Prob > F	0,0000			

Household Operations
Collective model, deferential preferences

	Coefficient	Robust SE	t-stat	p-value
rho: (0.225 , 0.3)	0,417554	0,0968376	4,31	0,000
ln (Total Expenditures)	0,286633	0,1342075	2,14	0,033
[ln (Total Expenditures)]^2	-0,013989	0,0068995	-2,03	0,043
Husband hours worked per week	-0,000245	0,0002576	-0,95	0,342
Wife hours worked per week	-0,000009	0,000401	-0,02	0,982
Husband age	-0,000940	0,0005063	-1,86	0,064
Wife age	0,001559	0,0029868	0,52	0,602
Wife age^2	-0,000034	0,0000361	-0,95	0,343
Husband education beyond high school	0,007750	0,005014	1,55	0,123
Husband master's degree and beyond	-0,003733	0,0085317	-0,44	0,662
Wife education beyond high school	0,007527	0,004906	1,53	0,125
Wife master's degree and beyond	0,036675	0,0078599	4,67	0,000
Children under 2 years	0,021407	0,0074276	2,88	0,004
Children 2 to 15 years	0,006104	0,0029309	2,08	0,038
Houseowner	0,007309	0,0054988	1,33	0,184
Region Midwest	0,018414	0,0073289	2,51	0,012
Region South	0,015122	0,0067089	2,25	0,024
Region West	0,006431	0,0068749	0,94	0,350
Metropolitan residence	0,004483	0,0073889	0,61	0,544
Husband black	0,015228	0,0120042	1,27	0,205
Wife black	-0,025063	0,0131265	-1,91	0,057
Husband Asian	-0,005081	0,0149765	-0,34	0,735
Wife Asian	-0,005087	0,0146909	-0,35	0,729
Wife other	-0,009955	0,0089269	-1,12	0,265
Husband other	0,012958	0,0201562	0,64	0,520
_cons	-1,447953	0,6550752	-2,21	0,027
Number of obs.	812			
R2	0,2030			
F(25, 786)	8,17			
Prob > F	0,0000			

Household Equipment
Collective model, egotistic preferences

	Coefficient	Robust SE	t-stat	p-value
rho	-0,007548	0,009392	-0,80	0,422
ln (Total Expenditures)	0,195483	0,077200	2,53	0,012
[ln (Total Expenditures)]^2	-0,009345	0,003968	-2,36	0,019
Husband hours worked per week	0,000012	0,000188	0,07	0,948
Wife hours worked per week	-0,000036	0,000246	-0,15	0,884
Husband age	-0,000229	0,000355	-0,65	0,518
Wife age	-0,003268	0,002159	-1,51	0,131
Wife age^2	0,000046	0,000028	1,68	0,094
Husband education beyond high school	0,000990	0,004293	0,23	0,818
Husband master's degree and beyond	-0,001564	0,004541	-0,34	0,731
Wife education beyond high school	-0,001141	0,003900	-0,29	0,770
Wife master's degree and beyond	-0,005049	0,003708	-1,36	0,174
Children under 2 years	-0,003870	0,003792	-1,02	0,308
Children 2 to 15 years	-0,001940	0,002059	-0,94	0,346
Houseowner	0,000317	0,003564	0,09	0,929
Region Midwest	0,008503	0,004063	2,09	0,037
Region South	0,012416	0,004226	2,94	0,003
Region West	0,004078	0,003486	1,17	0,242
Metropolitan residence	-0,004036	0,005435	-0,74	0,458
Husband black	-0,000826	0,006055	-0,14	0,891
Wife black	-0,007995	0,007346	-1,09	0,277
Husband Asian	0,013596	0,007433	1,83	0,068
Wife Asian	-0,014266	0,006725	-2,12	0,034
Wife other	-0,004118	0,007926	-0,52	0,604
Husband other	0,000156	0,012031	0,01	0,990
_cons	-0,922720	0,370615	-2,49	0,013

Number of obs.	812
R2	0.0426
F(25, 786)	2,11
Prob > F	0,0013

Health Insurance

Collective model, egotistic preferences

	Coefficient	Robust SE	t-stat	p-value
rho	0,0254036	0,0089729	2,83	0,005
ln (Total Expenditures)	0,1530555	0,0983895	1,56	0,120
[ln (Total Expenditures)]^2	-0,0084633	0,0050006	-1,69	0,091
Husband hours worked per week	-0,0001079	0,0001444	-0,75	0,455
Wife hours worked per week	-0,0004948	0,0002388	-2,07	0,039
Husband age	0,0004613	0,0003347	1,38	0,168
Wife age	-0,0059482	0,0024534	-2,42	0,016
Wife age^2	0,0000641	0,0000311	2,06	0,040
Husband education beyond high school	-0,0018386	0,0029433	-0,62	0,532
Husband master's degree and beyond	0,0045275	0,0033953	1,33	0,183
Wife education beyond high school	-0,0012967	0,0033604	-0,39	0,700
Wife master's degree and beyond	0,0031424	0,0030739	1,02	0,307
Children under 2 years	-0,0035098	0,0039869	-0,88	0,379
Children 2 to 15 years	0,0037683	0,0018050	2,09	0,037
Houseowner	-0,0052775	0,0042506	-1,24	0,215
Region Midwest	0,0086442	0,0043373	1,99	0,047
Region South	0,0032387	0,0043353	0,75	0,455
Region West	0,0028235	0,0046167	0,61	0,541
Metropolitan residence	0,0057008	0,0047256	1,21	0,228
Husband black	-0,0187678	0,0082009	-2,29	0,022
Wife black	0,0170958	0,0090525	1,89	0,059
Husband Asian	-0,0063727	0,0053951	-1,18	0,238
Wife Asian	-0,0081705	0,0050619	-1,61	0,107
Wife other	0,0057045	0,0060623	0,94	0,347
Husband other	-0,0378350	0,0068677	-5,51	0,000
_cons	-0,5341291	0,4906517	-1,09	0,277

Number of obs.	812
R2	0.0859
F(25, 786)	3,78
Prob > F	0.0000

Health Insurance

Collective model, deferential preferences

	Coefficient	Robust SE	t-stat	p-value
rho: (0.425 , 0.5)	0,1438125	0,0381212	3,77	0,000
ln (Total Expenditures)	0,1616056	0,0970209	1,67	0,096
[ln (Total Expenditures)]^2	-0,0088727	0,0049353	-1,80	0,073
Husband hours worked per week	-0,000089	0,0001421	-0,63	0,531
Wife hours worked per week	-0,0004885	0,0002353	-2,08	0,038
Husband age	0,0005229	0,0003334	1,57	0,117
Wife age	-0,0058871	0,002428	-2,42	0,016
Wife age^2	0,0000627	0,0000307	2,04	0,042
Husband education beyond high school	-0,001661	0,0029193	-0,57	0,570
Husband master's degree and beyond	0,0051239	0,0034263	1,50	0,135
Wife education beyond high school	-0,0015261	0,0033362	-0,46	0,647
Wife master's degree and beyond	0,0027516	0,0030621	0,90	0,369
Children under 2 years	-0,0033705	0,0039611	-0,85	0,395
Children 2 to 15 years	0,0038202	0,0017882	2,14	0,033
Houseowner	-0,0058207	0,0041992	-1,39	0,166
Region Midwest	0,0090987	0,0043826	2,08	0,038
Region South	0,0034261	0,0043706	0,78	0,433
Region West	0,0025491	0,0046021	0,55	0,580
Metropolitan residence	0,0061204	0,0047171	1,30	0,195
Husband black	-0,0191329	0,0082568	-2,32	0,021
Wife black	0,0180634	0,0091332	1,98	0,048
Husband Asian	-0,0058829	0,0054287	-1,08	0,279
Wife Asian	-0,0086991	0,0051406	-1,69	0,091
Wife other	0,0050026	0,005959	0,84	0,401
Husband other	-0,0370346	0,0070868	-5,23	0,000
_cons	-0,576148	0,4836734	-1,19	0,234

Number of obs.	812
R2	0,0926
F(25, 786)	3,67
Prob > F	0.0000

Health Insurance
Nash bargaining model, deferential preferences

	Coefficient	Robust SE	t-stat	p-value
rho: (0.2 , .0275)	0,1058415	0,0690678	1,53	0,126
rho: (0.425 , 0.5)	0,132648	0,0395109	3,36	0,001
ln (Total Expenditures)	0,1617085	0,0974677	1,66	0,097
[ln (Total Expenditures)]^2	-0,0088643	0,0049586	-1,79	0,074
Husband hours worked per week	-0,0000766	0,0001425	-0,54	0,591
Wife hours worked per week	-0,0004962	0,0002336	-2,12	0,034
Husband age	0,0005664	0,0003382	1,67	0,094
Wife age	-0,0059055	0,002433	-2,43	0,015
Wife age^2	0,0000625	0,0000308	2,03	0,043
Husband education beyond high school	-0,0015872	0,0029171	-0,54	0,587
Husband master's degree and beyond	0,0048234	0,0034445	1,40	0,162
Wife education beyond high school	-0,0019648	0,0033506	-0,59	0,558
Wife master's degree and beyond	0,0028324	0,0030561	0,93	0,354
Children under 2 years	-0,0030878	0,0039649	-0,78	0,436
Children 2 to 15 years	0,0041247	0,0018201	2,27	0,024
Houseowner	-0,0058367	0,004213	-1,39	0,166
Region Midwest	0,0094029	0,0043869	2,14	0,032
Region South	0,0038968	0,0043495	0,90	0,371
Region West	0,0028395	0,0045844	0,62	0,536
Metropolitan residence	0,0053473	0,0046663	1,15	0,252
Husband black	-0,0192443	0,0082032	-2,35	0,019
Wife black	0,0179057	0,0090858	1,97	0,049
Husband Asian	-0,0060808	0,0053831	-1,13	0,259
Wife Asian	-0,0084534	0,0050801	-1,66	0,097
Wife other	0,0056269	0,005848	0,96	0,336
Husband other	-0,0374156	0,0070988	-5,27	0,000
_cons	-0,5859162	0,4855111	-1,21	0,228

Number of obs.	812
R2	0.0941
F(25, 785)	3,57
Prob > F	0.0000

TV, radio and sound equipment
Collective model, egotistic preferences

	Coefficient	Robust SE	t-stat	p-value
rho	-0,0190316	0,0053153	-3,58	0,000
ln (Total Expenditures)	-0,0888220	0,0554132	-1,60	0,109
[ln (Total Expenditures)]^2	0,0043213	0,0028316	1,53	0,127
Husband hours worked per week	-0,0000962	0,0000975	-0,99	0,324
Wife hours worked per week	0,0000833	0,0001092	0,76	0,446
Husband age	-0,0000893	0,0001989	-0,45	0,654
Wife age	0,0002983	0,0010235	0,29	0,771
Wife age^2	-0,0000013	0,0000130	-0,10	0,922
Husband education beyond high school	-0,0005905	0,0016140	-0,37	0,715
Husband master's degree and beyond	-0,0007166	0,0025682	-0,28	0,780
Wife education beyond high school	0,0007372	0,0016403	0,45	0,653
Wife master's degree and beyond	-0,0024277	0,0019506	-1,24	0,214
Children under 2 years	-0,0025353	0,0021337	-1,19	0,235
Children 2 to 15 years	-0,0009822	0,0009837	-1,00	0,318
Houseowner	0,0002044	0,0021535	0,09	0,924
Region Midwest	-0,0001178	0,0024784	-0,05	0,962
Region South	0,0007700	0,0022620	0,34	0,734
Region West	-0,0016724	0,0025655	-0,65	0,515
Metropolitan residence	0,0024379	0,0022422	1,09	0,277
Husband black	0,0065732	0,0052992	1,24	0,215
Wife black	-0,0038002	0,0057437	-0,66	0,508
Husband Asian	0,0033479	0,0036586	0,92	0,360
Wife Asian	-0,0035122	0,0033142	-1,06	0,290
Wife other	-0,0058027	0,0056613	-1,02	0,306
Husband other	0,0002990	0,0064183	0,05	0,963
_cons	0,4796672	0,2669665	1,80	0,073

Number of obs.	812
R2	0.0506
F(25, 786)	2,23
Prob > F	0,0005

TV, Radio and Sound Equipment
Collective model, wife deferential preferences

	Coefficient	Robust SE	t-stat	p-value
rho: (.,.5)	-0,0304152	0,0077981	-3,90	0,000
ln (Total Expenditures)	-0,0933640	0,0558552	-1,67	0,095
[ln (Total Expenditures)]^2	0,0045310	0,0028534	1,59	0,113
Husband hours worked per week	-0,0000944	0,0000959	-0,98	0,325
Wife hours worked per week	0,0000690	0,0001050	0,66	0,511
Husband age	-0,0001288	0,0001982	-0,65	0,516
Wife age	0,0002250	0,0010134	0,22	0,824
Wife age^2	0,0000000	0,0000129	0,00	1,000
Husband education beyond high school	-0,0005302	0,0016155	-0,33	0,743
Husband master's degree and beyond	-0,0005659	0,0025477	-0,22	0,824
Wife education beyond high school	0,0010220	0,0016489	0,62	0,536
Wife master's degree and beyond	-0,0025775	0,0019279	-1,34	0,182
Children under 2 years	-0,0024861	0,0021280	-1,17	0,243
Children 2 to 15 years	-0,0011093	0,0009833	-1,13	0,260
Houseowner	0,0006290	0,0021357	0,29	0,768
Region Midwest	-0,0003925	0,0024832	-0,16	0,874
Region South	0,0002055	0,0022386	0,09	0,927
Region West	-0,0018306	0,0025522	-0,72	0,473
Metropolitan residence	0,0027401	0,0022060	1,24	0,215
Husband black	0,0062902	0,0052766	1,19	0,234
Wife black	-0,0035248	0,0057314	-0,61	0,539
Husband Asian	0,0028659	0,0036285	0,79	0,430
Wife Asian	-0,0033711	0,0032997	-1,02	0,307
Wife other	-0,0054937	0,0055279	-0,99	0,321
Husband other	-0,0005156	0,0057026	-0,09	0,928
_cons	0,5108141	0,2697139	1,89	0,059

Number of obs.	812
R2	0.0554
F(25, 786)	2,47
Prob > F	0,0001

Appendix B: Mapping of UCC-Codes to dependent variables

This appendix maps the UCC-codes to the aggregate goods I chose as dependent variables for the estimations. It also lists sub-categories that are computed by the BLS where relevant.

CHILDREN'S CLOTHING

GRLFIFPQ + GRLFIFCQ - Clothing for girls, 2 to 15
390110 Girls' coats, jackets, and furs
390120 Girls' dresses and suits
390210 Girls' sport coats, tailored jackets, shirts, blouses, sweaters, sweater sets, and vests
390211 Girls' shirts, blouses or sweaters
390212 Girls' shorts or shorts sets
390223 Girls' pants and shorts
390230 Girls' swimsuits, warm-up or ski suits
390310 Girls' undergarments and nightwear
390321 Girls' hosiery
390322 Girls' accessories
390901 Girls' uniforms
390902 Girls' other clothing, incl. costumes

BOYFIFPQ BOYFIFCQ - Clothing for boys, 2 to 15
370110 Boys' coats, jackets, and furs
370120 Boys' sweaters
370130 Boys' shirts
370211 Boys' underwear
370212 Boys' nightwear
370213 Boys' hosiery
370220 Boys' accessories
370311 Boys' suits, sport coats, and vests
370312 Boys' pants
370313 Boys' Boys shorts or shorts sets
370314 Boys' pants and shorts
370902 Boys' other clothing, incl. costumes
370903 Boys' uniforms
370904 Boys' swimsuits, warm-up or ski suits

CHLDRNPQ + CHLDRNCQ - Clothing for children under 2
410110 Infants' coats, jackets, and snowsuits
410120 Infants' dresses and other outerwear
410130 Infants' undergarments, incl. diapers
410140 Infants' sleeping garments
410901 Infants' accessories, hosiery, and footwear

HOUSEHOLD OPERATIONS

DMSXCCPQ + DMSXCCCQ - Domestic services excluding child care
340310 Housekeeping service, incl. management fees for maid service in condos
340410 Gardening and lawn care services, incl. management fees for lawn care in coops and condos
340420 Water softening service
340520 Non-clothing household laundry or dry cleaning – not coin-operated
340530 Non-clothing household laundry or dry cleaning – coin-operated
340903 Miscellaneous home services and small repair jobs not already specified
340914 Services for termite/pest control maintenance

(340906 Care for invalids, convalescents, handicapped or elderly persons in the CU)
(340910 Adult day care centers)
The BLS also include the above two UCCs in the Domestic Services variable, but none of the households in the sample have any recorded expenditures in these categories.

BBYDAYPQ + BBYDAYCQ - Babysitting and child day care
340211 Babysitting or other child care in your own home
340212 Babysitting or other child care in someone else's home
670310 Other expenses for day care centers and nursery schools, including tuition

OTHHEXPQ + OTHHEXCQ - Other household expenses
330511 Cost of materials purchased for termite and pest control for jobs considered replacement or maintenance/repair
340510 Moving, storage, and freight express
340620 Repair of household appliances, excl. garbage disposal, range hood, and built-in dishwasher
340630 Furniture repair, refinishing, or reupholstering
340901 Rental or repair of equipment and other yard machinery, power and non-power tools
340907 Rental and installation of household equipment
340908 Rental of office equipment for non-business use
340915 Service fee expenditures for home security systems
690113 Repair of computers, computer systems, and related equipment for non-business use
690114 Computer information services
690116 Internet services away from home
690310 Installation for computers
990900 Rental and installation of dishwasher, disposal, and range hood

HOUSEHOLD EQUIPMENT

TEXTILPQ Household textiles last quarter
280110 Bathroom linens
280120 Bedroom linens
280130 Kitchen and dining room linens
280210 Curtains and drapes
280220 Slipcovers, decorative pillows, and cushions
280230 Sewing materials for slipcovers, curtains, and other home handiwork
280900 Other linens

FURNTRPQ Furniture last quarter
290110 Mattresses and springs
290120 Other bedroom furniture
290210 Sofas
290310 Living room chairs
290320 Living room tables
290410 All kitchen and dining room furniture
290420 Infants' furniture
290430 Patio, porch, or outdoor furniture
290440 Modular wall units, shelves or cabinets; other living room, family or recreation room furniture including desks

FLRCVRPQ Floor coverings last quarter
230133 Installed and non-installed replacement wall to wall carpeting for owned homes
230134 Installed and non-installed original wall to wall carpeting for rental homes
320111 Carpet squares for owned and rented homes (Non-Permanent)
320163Installed and non-installed replacement wall to wall carpeting for rental homes

MAJAPPPQ Major appliances last quarter
230117 Built-in dishwasher, garbage disposal, or range hood for jobs considered replacement or maintenance/repair - renter
230118 Same as 230117 - owned home
300112 Purchase and installation of refrigerator or home freezer – homeowner
300211 Purchase and installation of clothes washer – renter
300212 Purchase and installation of clothes washer – homeowner
300221 Purchase and installation of clothes dryer – renter
300222 Purchase and installation of clothes dryer – homeowner
300311 Purchase and installation of cooking stove, range or oven, excl. microwave – renter
300312 Purchase and installation of cooking stove, range or oven, excl. microwave – homeowner
300321 Purchase and installation of microwave oven – renter
300322 Purchase and installation of microwave oven – homeowner
300331 Purchase and installation of portable dishwasher – renter
300332 Purchase and installation of portable dishwasher – homeowner
300411 Window air conditioner – renter
300412 Window air conditioner – homeowner
320511 Electric floor cleaning equipment
320512 Sewing machines

SMLAPPPQ Small appliances, miscellaneous housewares last quarter
320310 PLASTIC DINNERWARE
320320 CHINA AND OTHER DINNERWARE
320330 FLATWARE
320340 GLASSWARE
320350 SILVER SERVING PIECES
320360 OTHER SERVING PIECES
320370 NONELECTRIC COOKWARE
320521 SMALL ELECTRIC KITCHEN APPLIANCES
320522 PORTABLE HEATING/COOLING EQUIP

MISCEQPQ Miscellaneous household equipment last quarter
320120 Venetian blinds, window shades and other window coverings
320130 Infants' equipment
320150 Barbeque grills and outdoor equipment 320220 LAMPS AND LIGHTING FIXTURES
320232 Telephones and accessories
320233 Clocks and other household decorative items
320410 Lawn mowing equipment and other yard machinery
320420 Power tools
320901 Office furniture for home use
320902 Non-power tools
320903 Fresh flowers or potted plants
320904 Closet storage items
430130 Travel items, including luggage, and luggage carriers
690111 Computers, computer systems, and related hardware for non-business use
690112 Computer software and accessories for non-business use
690115 Personal digital assistants
690210 Telephone answering devices
690230 Typewriters and other office machines for non-business use
690241 Purchases and rentals of smoke alarms and detectors – renter
690242 Same as 690241 – owned home
690243 Same as 690241 – owned vacation home
690244 Other household appliances – renter
690245 Same as 690244 – homeowner
690117 Portable memory

HEALTH INSURANCE

580111Traditional fee for service health plan (not BC/BS)
580112 Traditional fee for service health plan (BC/BS)
580113 Preferred provider health plan (not BC/BS)
580114 Preferred provider health plan (BC/BS)
580311 Health maintenance organization (not BC/BS)
580312 Health maintenance organization (BC/BS)
580400 Long Term Care insurance
580901 Medicare payment
580903 Commercial Medicare supplement (not BC/BS)
580904 Commercial Medicare supplement (BC/BS)
580905 Other health insurance (not BC/BS)
580906 Other health insurance (BC/BS)
580907 Medicare Prescription Drug premium

TV, RADIO AND SOUND EQUIPMENT

270310 Cable, satellite, or community antenna service
270311 Satellite radio service
310140 Televisions
310210 Video cassette recorders or video disc players
310220 Video cassettes, tapes, and discs
310230 Video and computer game hardware and software
310240 Streaming or downloaded video files
310311 Radio
310313 Tape recorder and player
310314 Digital audio players
310320 Sound components, component systems, and compact disc sound systems
310333 Accessories and other sound equipment including phonographs
310334 Satellite dishes
310340 Records, CDs, audio tapes
310350 Streaming or downloaded audio files
340610 Repair of television, radio, and sound equipment, excluding installed in vehicles
340902 Rental of televisions
340905 Rental of VCR, radio, and sound equipment
610130 Musical instruments, supplies, and accessories (now includes pianos)
620904 Rental and repair of musical instruments, supplies, and accessories (now includes pianos)
620912 Rental of video cassettes, tapes, and discs
620916 Rental of video or computer hardware or software
690320 Installation for TVs
690330 Installation for satellite TV equipment
690340 Installation of sound systems
690350 Installation of other video or sound systems

Appendix C: Table of correlations between the wife's share of income and variables relating to time decisions and income.

The table below provides an illustration of the possible endogeneity issues discussed in section 4.1.4.

	Wife's share of individually reported income, ρ
Weekly hours worked by the wife	0.10
Ratio of wife's working hours to couple's working hours	0.23
Wife's reported income	0.45
Wife's and husbands reported (individual) income	-0.09
Total expenditures	-0.05

Appendix D: Mathematical note on Becker-regions.

This appendix elaborates on the exposition of Becker-regions in section 3.3.3 where it was claimed that transfers in the Warr-region will be zero, and that the result does not rely on using log-utility functions (Browning and Lechene 2001). The general utility functions from (3.9) were:

$$U^h = v^h\left(x_h, G\right)$$
$$U^w = \psi^w\left(v^h\left(x_h, G\right), v^w\left(x_w, G\right)\right)$$

Substitute the budget constraints for the husband and the wife into the wife's utility function to get:

$$\begin{aligned} U^w &= \psi^w\left(v^h\left(y_h - g_h + t, g_h + g_w\right), v^w\left(y_w - g_w - t, g_h + g_w\right)\right) \\ U_t^w &= \psi_h v_x^h - \psi_w v_x^w \end{aligned} \tag{I}$$

Furthermore, we know that for an interior solution where both contribute to the public good, we must have:

$$\begin{aligned} v_x^h &= v_g^h \\ \psi_w^w v_x^w &= \psi_h^w v_G^h + \psi_w^w v_G^w \end{aligned} \tag{II}$$

Substituting from the second line in (II) into the second line in (I):

$$U_t^w = \psi_h^w v_x^h - \psi_w^w v_x^w = \psi_h^w v_G^h - \left(\psi_h^w v_g^h + \psi_w^w v_G^w\right) = -\psi_w^w v_G^w < 0 \tag{III}$$

Hence, when both are contributing to the public good, the marginal utility of a transfer is less than zero – and there will be no transfer. Also, if the husband is the only person contributing to the public good, then there will be no transfers since he has egotistical preferences. But if the wife is the only person contributing to the public good, there might be transfers. Using the second equality in (III) and the second line in (II), we see that transfers will be positive when

$$\psi_h^w\left(v_x^h - v_G^h\right) - \psi_w^w v_G^w > 0$$

The first term on the left hand side is positive or zero, since when the husband is not contributing, $V_x^1 \geq V_g^1$. The second term is negative. So in order for transfers to be positive, the

wife must value his utility gain from increased consumption of the private good and reduced consumption of the public good *more* than she values her own consumption of the public good.